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Literature Survey for Issues Surrounding Intuitive Decision Making Training and Decision Support for Military Planning

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Abstract

The intention of Project Minerva is to re-examine Land Force Command and Control (C2) in light of the implementation of digitized C2 systems. This will be done within the context of the Athene Tactical System, which is to be delivered over the next year. The Land Force wants to develop new procedures that capitalize on the strengths of digitization. Project Minerva will focus on the Operations Planning Process (OPP), which is the prescribed method of planning for a mission.

The OPP, as described in doctrine, is an analytical approach to planning. That is, the doctrine requires the planner to consider exhaustively all the factors affecting a mission and develop a number of potential Courses of Action (COA). The fresh consideration of the OPP permits the consideration of alternative styles of decision making. In the past 15 – 20 years much attention has been paid to so-called Naturalistic Decision Making (NDM) styles. These styles are alternatively known as 'intuitive' or 'recognition-primed' and are considered more representative of the style adopted by most people much of the time.

It is hoped that Project Minerva will afford the opportunity to compare and contrast the analytical and intuitive decision making approaches within the context of operations planning. The outcome will provide valuable data that can be used in the development of digitized C2 systems. As a first step toward this opportunity, a literature survey was undertaken to identify literature that would likely be relevant to a discussion of decision making in planning and the training of decision making skills, as well as development of new planning and training concepts. A particular emphasis was placed on literature that focused on intuitive approaches.

This report provides an annotated bibliography of the decision making literature deemed to be of highest relevance to the aims of Project Minerva. This literature is categorised into high, medium and low relevance (low relevance is merely a comparative term; the papers are still relevant to the discussion). Further, the main issues apparent from the literature associated with decision making in planning are summarised.

Resumé

Le projet Minerva réexamine le commandement et le contrôle (C2) de la Force terrestre à la lumière de la mise en application de systèmes C2 numérisés, et ce, dans le cadre de la mise en œuvre du Système tactique Athene, qui aura lieu au cours de l'année prochaine. La Force terrestre veut élaborer de nouvelles procédures qui mettront à profit les forces de la numérisation. Le projet Minerva portera principalement sur le processus de planification opérationnel (PPO), la méthode de planification prescrite pour une mission.

Le PPO, tel que présenté dans la doctrine, est une approche analytique de la planification. C'est-à-dire que la doctrine oblige le planificateur à étudier en profondeur tous les facteurs pouvant influer sur une mission et à considérer un certain nombre d'options. Le nouveau type d'examen du PPO permet d'envisager d'autres styles de processus décisionnel. Au cours des 15 à 20 dernières années, on a porté une grande attention aux soi-disant styles de prise de décision naturalistes. Ces styles, sont parfois appelés « intuitifs » ou « basés sur la reconnaissance », et l'on estime qu'il représentent davantage le style adopté par la majorité des gens la plupart du temps.

Nous espérons que le projet Minerva nous permettra de mettre en contraste les processus décisionnels dits analytiques et intuitifs pour les comparer dans le cadre de la planification opérationnelle. Les résultats offriront des données utiles qui pourront servir lors de l'élaboration de systèmes C2 numérisés. À titre de premier pas vers cette réalisation, on a entrepris une recherche bibliographique pour identifier les documents pertinents à l'étude du processus décisionnel appliqué à la planification et au développement d'habiletés en matière de prise de décision, ainsi qu'à l'élaboration de nouveaux concepts de planification et d'entraînement. On a mis un accent particulier sur la documentation portant sur les approches intuitives.

Ce rapport comprend une bibliographie commentée des documents traitant du processus décisionnel, qui présentent le plus grand intérêt à l'égard des buts du projet Minerva. La documentation est classée selon trois degrés de pertinence : haute, moyenne et basse (la cote « basse » n'est qu'un terme de comparaison – les travaux demeurent pertinents aux fins de l'étude). De plus, les enjeux principaux qui ressortent de la documentation et qui sont liés au processus décisionnel appliqué à la panification ont fait l'objet d'un résumé.

Executive Summary

The intention of Project Minerva is to re-examine Land Force Command and Control (C2) in light of the implementation of digitized C2 systems. This will be done within the context of the Athene Tactical System, which is to be delivered over the next year. The Land Force wants to develop new procedures that capitalize on the strengths of digitization. Project Minerva will focus on the Operations Planning Process (OPP), which is the prescribed method of planning for a mission.

The OPP, as described in doctrine, is an analytical approach to planning. That is, the doctrine requires the planner to consider exhaustively all the factors affecting a mission and develop a number of potential Courses of Action (COA). The fresh consideration of the OPP permits the consideration of alternative styles of decision making. In the past 15 – 20 years much attention has been paid to so-called Naturalistic Decision Making (NDM) styles. These styles are alternatively known as 'intuitive' or 'recognition-primed' and are considered more representative of the style adopted by most people much of the time.

It is hoped that Project Minerva will afford the opportunity to compare and contrast the analytical and intuitive decision making approaches within the context of operations planning. This would require an alternative training approach to be developed that incorporated intuitive decision making styles. The outcome will provide valuable data that can be used in the development of digitized C2 systems. As a first step toward this opportunity, a literature survey was undertaken to identify literature that would likely be relevant to a discussion of decision making in planning and the training of decision making skills, as well as development of new planning and training concepts. A particular emphasis was placed on literature that focused on intuitive approaches.

This report provides an annotated bibliography of the decision making literature deemed to be of highest relevance to the aims of Project Minerva. This literature is categorised into high, medium and low relevance (low relevance is merely a comparative term; the papers are still relevant to the discussion). Further, the main issues apparent from the literature associated with decision making in planning are summarised.

A total of 110 references were identified as relevant. Of these, 37 were relevant but could not be categorised; 15 were categorised 'high'; 27 were categorised 'medium'; and 31 were categorised 'low'. The main concepts apparent from this literature centred on a comparison of intuitive and analytical decision making approaches, the situations when each would be appropriate, and training of decision making approaches.

Sommaire

Le projet Minerva réexamine le commandement et le contrôle (C2) de la Force terrestre à la lumière de la mise en application de systèmes C2 numérisés, et ce, dans le cadre de la mise en œuvre du Système tactique Athene, qui aura lieu au cours de l'année prochaine. La Force terrestre veut élaborer de nouvelles procédures qui mettront à profit les forces de la numérisation. Le projet Minerva portera principalement sur le processus de planification opérationnel (PPO), la méthode de planification prescrite pour une mission.

Le PPO, tel que présenté dans la doctrine, est une approche analytique de la planification. C'est-à-dire que la doctrine oblige le planificateur à étudier en profondeur tous les facteurs pouvant influer sur une mission et à considérer un certain nombre d'options. Le nouveau type d'examen du PPO permet d'envisager d'autres styles de processus décisionnel. Au cours des 15 à 20 dernières années, on a porté une grande attention aux soi-disant styles de prise de décision naturalistes. Ces styles, sont parfois appelés « intuitifs » ou « basés sur la reconnaissance », et l'on estime qu'il représentent davantage le style adopté par la majorité des gens la plupart du temps.

Nous espérons que le projet Minerva nous permettra de mettre en contraste les processus décisionnels dits analytiques et intuitifs pour les comparer dans le cadre de la planification opérationnelle. Cette comparaison nécessiterait l'élaboration d'une nouvelle méthode de formation qui intègre les styles intuitifs de processus décisionnel. Les résultats offriront des données utiles qui pourront servir lors de l'élaboration de systèmes C2 numérisés. À titre de premier pas vers cette réalisation, on a entrepris une recherche bibliographique pour identifier les documents pertinents à l'étude du processus décisionnel appliqué à la planification et au développement d'habiletés en matière de prise de décision, ainsi qu'à l'élaboration de nouveaux concepts de planification et d'entraînement. On a mis un accent particulier sur la documentation portant sur les approches intuitives.

Ce rapport comprend une bibliographie commentée des documents traitant du processus décisionnel, qui présentent le plus grand intérêt à l'égard des buts du projet Minerva. La documentation est classée selon trois degrés de pertinence : haute, moyenne et basse (la cote « basse » n'est qu'un terme de comparaison – les travaux demeurent pertinents aux fins de l'étude). De plus, les enjeux principaux qui ressortent de la documentation et qui sont liés au processus décisionnel appliqué à la panification ont fait l'objet d'un résumé.

Un total de 110 références pertinentes ont été recensées. De ce nombre, 37 n'ont pas été classées, 15 ont reçu la cote « haute », 27 « moyenne » et 31 « basse ». Les grandes lignes dégagées de cette documentation portaient principalement sur une comparaison entre les approches intuitives et analytiques de prise de décision, les situations dans lesquelles chacune est appropriée et les approches en ce qui concerne la formation portant sur le processus décisionnel.

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1. Introduction

1.1. Background

The intention of Project Minerva is to re-examine Land Force Command and Control (C2) in light of the implementation of digitized C2 systems. This will be done within the context of the Athene Tactical System, which is to be delivered over the next year. The Land Force wants to develop new procedures that capitalize on the strengths of digitization.

Project Minerva will focus on the Operations Planning Process (OPP), which is the prescribed method of planning for a mission. Although the OPP was developed without any explicit relation to psychological theories of problem solving and decision making, it is consistent with what has been termed analytic decision making (Bryant, Webb, and McCann; 2003). In particular, the OPP affirms two major premises of analytic decision making; i.e. 1) multiple solutions to the problem must be evaluated and the best selected, and 2) evaluation of solution alternatives must be performed through exhaustive factor-by-factor comparison.

Research in the cognitive sciences has suggested that a large portion of human decision making is conducted intuitively; i.e by less formal, non-analytic processes. This suggests that there may be a mismatch between the OPP as laid out in doctrine and taught at training and education institutions within the Canadian Forces (CF), and the planning process as practiced by command teams in the field. In particular, command teams at Brigade level and below may engage in a more intuitive process than the doctrinal OPP (Bryant, 2003). An intuitive planning process may be preferable to an analytic process as intuitive reasoning has been demonstrated to require less information and consume less time than strictly analytic processes. Even where analytic processes have advantages, innate tendencies of humans to think intuitively may reduce the effectiveness of an analytic procedure like the OPP when put into practice. These arguments for intuitive procedures, however, may not apply when decision making is considered in the context of highly complex, dynamic problem scenarios involving many different planning participants.

To summarize, Project Minerva will compare the OPP as it is currently laid out in doctrine to the application of the OPP as conducted by representative command teams in realistic scenarios. The current phase of the project (i.e. current work) is to conduct a literature review focussed on decision making, problem solving and judgement as they related to planning processes. Particular attention will be paid to literature that describes intuitive examples of these processes, and to the manner in which intuitive processes can be taught. The results of this project will form the basis for future work comparing existing instruction in the OPP and experimental instruction in an 'intuitive' OPP.

The current project has been contracted to Humansystems Incorporated as a call-up under Standing Offer **W7711-01-7747**. The Scientific Authority (SA) for this work is Dr David Bryant.

1.2. Purpose

The objective of this project is to perform a survey of current scientific literature relevant to non-analytical/intuitive planning procedures and mechanisms for training individuals in such intuitive approaches. The survey will identify relevant literature, summarise major concepts and themes, and provide a bibliography of articles for subsequent use in development of planning and training

concepts to be examined in latter stages of Project Minerva. This project will not result in a detailed literature review. Where possible, this project will obtain the identified literature for later use in a detailed literature review.

1.3. Tasks

The following tasks were performed as part of this project:

- Non-analytical planning and training literature was searched to:
  - Identify relevant articles, book chapters, technical papers, etc.
  - Identify the major works in the literature that will be most valuable to subsequent research efforts.
- A partially annotated bibliography was produced containing full references of all relevant literature identified and summary notes of the most significant literature.
- This report was written, describing the literature search method and results, as well as brief summaries of the major concepts in the literature.

1.4. Approach Taken in this Report

The Method section lists the keywords used for the literature review. The databases searched are also listed in the Method section. The Results section lists the keywords and keyword combinations and describes the number of 'hits' (articles found). This provides some justification for combining keywords.

There follows a section that presents an annotated bibliography, categorised into 'high relevance', 'medium relevance' and 'low relevance'. The final section summarises the major concepts identified from this survey. Alphabetised references are provided at the end of this report, and a companion Endnote database exists, containing the annotated bibliography.

2. Method

The following keywords were used in this literature survey (Table 1).

Keyword	Modifying Keyword
"Decision Making" "Judgement" "Problem Solving" "Intuitive Decision Making" "Naturalistic Decision Making" "Recognition Primed Decision Making" "Intuitive Judgement" "Intuitive Problem Solving"	"Planning" "Planning Process" "Training" "Instruction"

Table 1: Keywords and modifiers used in this survey

Keywords were entered into the 'Search' function of the literature databases considered to act as a coarse filter to the relevant literature. If the search returned more than 100 relevant articles, a modifying keyword was applied to filter the returns to more closely reflect the needs of this study.

The following literature databases were searched in this survey (Table 2).

PsychInfo
Ergonomics Abstracts
Canada Institute for Scientific and Technical Information (CISTI)
National Technical Information Service (NTIS)
Defence Technical Information Centre (DTIC)

Table 2: Databases searched in this survey

Resultant hits were considered for their applicability to the eventual application for this information (i.e. the comparison of traditional OPP instruction with instruction in novel intuitive planning techniques). Assuming they were deemed applicable, they were then categorised according to whether they had 'high', 'medium' or 'low' relevance. Low relevance is not intended to mean that they did not make any contribution to the state of knowledge about non-analytical planning; rather that they only contributed a few bits of novel information. Articles of high relevance were so considered because they contain a great deal of information and shape the perception of the field.

It was possible to obtain the abstracts for most articles. A summary of the major concepts apparent from these abstracts was then written to provide an overview of the survey.

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3. Results

This section presents the breakdown of keyword hits according to each database. The total number of articles selected for more detailed consideration from each database is also listed. These figures may overlap between databases.

PsychInfo		
Keywords	**Hits**	**Selected**
"Decision Making"	1616	
"Judgement"	386	
"Problem Solving"	5007	
"Intuitive Decision Making"	10	1
"Naturalistic Decision Making"	28	1
"Recognition Primed Decision Making"	20	5
"Intuitive Judgement"	1	
"Intuitive Problem Solving"	19	5
"Decision Making" + "Planning"	119	
"Judgement" + "Planning"	0	
"Problem Solving" + "Planning"	89	5
"Intuitive Decision Making" + "Planning"	0	
"Naturalistic Decision Making" + "Planning"	0	
"Recognition Primed Decision Making" + "Planning"	0	
"Intuitive Judgement" + "Planning"	0	
"Intuitive Problem Solving" + "Planning"	0	
"Decision Making" + "Planning Process"	13	
"Judgement" + "Planning Process"	0	
"Problem Solving" + "Planning Process"	13	1
"Intuitive Decision Making" + "Planning Process"	0	
"Naturalistic Decision Making" + "Planning Process"	0	
"Recognition Primed Decision Making" + "Planning Process"	0	
"Intuitive Judgement" + "Planning Process"	0	
"Intuitive Problem Solving" + "Planning Process"	0	
"Decision Making" + "Training"	97	9
"Judgement" + "Training"	3	1
"Problem Solving" + "Training"	332	
"Intuitive Decision Making" + "Training"	1	1
"Naturalistic Decision Making" + "Training"	1	1

PsychInfo		
Keywords	**Hits**	**Selected**
"Recognition Primed Decision Making" + "Training"	0	
"Intuitive Judgement" + "Training"	0	
"Intuitive Problem Solving" + "Training"	0	
"Decision Making" + "Instruction"	94	1
"Judgement" + "Instruction"	2	1
"Problem Solving" + "Instruction"	273	
"Intuitive Decision Making" + "Instruction"	0	
"Naturalistic Decision Making" + "Instruction"	0	
"Recognition Primed Decision Making" + "Instruction"	1	
"Intuitive Judgement" + "Instruction"	0	
"Intuitive Problem Solving" + "Instruction"	1	

Ergonomics Abstracts		
Keywords	**Hits**	**Selected**
"Decision Making"	4228	
"Judgement"	567	
"Problem Solving"	2273	
"Intuitive Decision Making"	0	
"Naturalistic Decision Making"	112	
"Recognition Primed Decision Making"	3	0
"Intuitive Judgement"	1	0
"Intuitive Problem Solving"	1	1
"Decision Making" + "Planning"	237	
"Judgement" + "Planning"	8	
"Problem Solving" + "Planning"	203	
"Intuitive Decision Making" + "Planning"	0	
"Naturalistic Decision Making" + "Planning"	6	2
"Recognition Primed Decision Making" + "Planning"		
"Intuitive Judgement" + "Planning"		
"Intuitive Problem Solving" + "Planning"		
"Decision Making" + "Planning Process"	7	0
"Judgement" + "Planning Process"	0	
"Problem Solving" + "Planning Process"	9	1
"Intuitive Decision Making" + "Planning Process"	0	
"Naturalistic Decision Making" + "Planning Process"	0	

Ergonomics Abstracts		
Keywords	**Hits**	**Selected**
"Recognition Primed Decision Making" + "Planning Process"		
"Intuitive Judgement" + "Planning Process"		
"Intuitive Problem Solving" + "Planning Process"		
"Decision Making" + "Training"	659	
"Judgement" + "Training"	55	3
"Problem Solving" + "Training"	333	
"Intuitive Decision Making" + "Training"	0	
"Naturalistic Decision Making" + "Training"	27	17
"Recognition Primed Decision Making" + "Training"		
"Intuitive Judgement" + "Training"		
"Intuitive Problem Solving" + "Training"		
"Decision Making" + "Instruction"	51	1
"Judgement" + "Instruction"	0	
"Problem Solving" + "Instruction"	114	
"Intuitive Decision Making" + "Instruction"	0	
"Naturalistic Decision Making" + "Instruction"	0	
"Recognition Primed Decision Making" + "Instruction"		
"Intuitive Judgement" + "Instruction"		
"Intuitive Problem Solving" + "Instruction"		

CISTI		
Keywords	**Hits**	**Selected**
"Decision Making"	343	4
"Judgement"	181	
"Problem Solving"	800	
"Intuitive Decision Making"	4	3
"Naturalistic Decision Making"	18	6
"Recognition Primed Decision Making"	3	
"Intuitive Judgement"	1	
"Intuitive Problem Solving"	0	
"Decision Making" + "Planning"	11	
"Judgement" + "Planning"	0	
"Problem Solving" + "Planning"	185	3
"Intuitive Decision Making" + "Planning"		
"Naturalistic Decision Making" + "Planning"		

CISTI		
Keywords	**Hits**	**Selected**
"Recognition Primed Decision Making" + "Planning"		
"Intuitive Judgement" + "Planning"		
"Intuitive Problem Solving" + "Planning"		
"Decision Making" + "Planning Process"	0	
"Judgement" + "Planning Process"	0	
"Problem Solving" + "Planning Process"	8	
"Intuitive Decision Making" + "Planning Process"		
"Naturalistic Decision Making" + "Planning Process"		
"Recognition Primed Decision Making" + "Planning Process"		
"Intuitive Judgement" + "Planning Process"		
"Intuitive Problem Solving" + "Planning Process"		
"Decision Making" + "Training"	0	
"Judgement" + "Training"	0	
"Problem Solving" + "Training"	97	4
"Intuitive Decision Making" + "Training"		
"Naturalistic Decision Making" + "Training"		
"Recognition Primed Decision Making" + "Training"		
"Intuitive Judgement" + "Training"		
"Intuitive Problem Solving" + "Training"		
"Decision Making" + "Instruction"	0	
"Judgement" + "Instruction"	0	
"Problem Solving" + "Instruction"	40	0
"Intuitive Decision Making" + "Instruction"		
"Naturalistic Decision Making" + "Instruction"		
"Recognition Primed Decision Making" + "Instruction"		
"Intuitive Judgement" + "Instruction"		
"Intuitive Problem Solving" + "Instruction"		

NTIS		
Keywords	**Hits**	**Selected**
"Decision Making"	271	
"Judgement"	602	
"Problem Solving"	364	
"Intuitive Decision Making"	7	

NTIS		
Keywords	**Hits**	**Selected**
"Naturalistic Decision Making"	30	5
"Recognition Primed Decision Making"	8	1
"Intuitive Judgement"	3	
"Intuitive Problem Solving"	0	
"Decision Making" + "Planning"	51	
"Judgement" + "Planning"	79	
"Problem Solving" + "Planning"	76	
"Intuitive Decision Making" + "Planning"		
"Naturalistic Decision Making" + "Planning"		
"Recognition Primed Decision Making" + "Planning"		
"Intuitive Judgement" + "Planning"		
"Intuitive Problem Solving" + "Planning"		
"Decision Making" + "Planning Process"	34	
"Judgement" + "Planning Process"	1	
"Problem Solving" + "Planning Process"	4	
"Intuitive Decision Making" + "Planning Process"		
"Naturalistic Decision Making" + "Planning Process"		
"Recognition Primed Decision Making" + "Planning Process"		
"Intuitive Judgement" + "Planning Process"		
"Intuitive Problem Solving" + "Planning Process"		
"Decision Making" + "Training"	291 (+ planning = 53)	2
"Judgement" + "Training"	17	
"Problem Solving" + "Training"	46	
"Intuitive Decision Making" + "Training"		
"Naturalistic Decision Making" + "Training"		
"Recognition Primed Decision Making" + "Training"		
"Intuitive Judgement" + "Training"		
"Intuitive Problem Solving" + "Training"		
"Decision Making" + "Instruction"	140 (+ planning = 29)	1
"Judgement" + "Instruction"	1	
"Problem Solving" + "Instruction"	106	
"Intuitive Decision Making" + "Instruction"		
"Naturalistic Decision Making" + "Instruction"		
"Recognition Primed Decision Making" + "Instruction"		

NTIS		
Keywords	**Hits**	**Selected**
"Intuitive Judgement" + "Instruction"		
"Intuitive Problem Solving" + "Instruction"		

DTIC		
Keywords	**Hits**	**Selected**
"Decision Making"	13304	14
"Judgement"	1342	
"Problem Solving"	5107	
"Intuitive Decision Making"	10	
"Naturalistic Decision Making"	44	7
"Recognition Primed Decision Making"	5	1
"Intuitive Judgement"	5	
"Intuitive Problem Solving"	0	
"Decision Making" + "Planning"	3672	10
"Judgement" + "Planning"	168	
"Problem Solving" + "Planning"	946	
"Intuitive Decision Making" + "Planning"		
"Naturalistic Decision Making" + "Planning"		
"Recognition Primed Decision Making" + "Planning"		
"Intuitive Judgement" + "Planning"		
"Intuitive Problem Solving" + "Planning"		
"Decision Making" + "Planning Process"	163	
"Judgement" + "Planning Process"	8	
"Problem Solving" + "Planning Process"	28	2
"Intuitive Decision Making" + "Planning Process"		
"Naturalistic Decision Making" + "Planning Process"		
"Recognition Primed Decision Making" + "Planning Process"		
"Intuitive Judgement" + "Planning Process"		
"Intuitive Problem Solving" + "Planning Process"		
"Decision Making" + "Training"	2035	
"Judgement" + "Training"	261	
"Problem Solving" + "Training"	577	
"Intuitive Decision Making" + "Training"		
"Naturalistic Decision Making" + "Training"		
"Recognition Primed Decision Making" + "Training"		

DTIC		
Keywords	**Hits**	**Selected**
"Intuitive Judgement" + "Training"		
"Intuitive Problem Solving" + "Training"		
"Decision Making" + "Instruction"	382	1
"Judgement" + "Instruction"	39	
"Problem Solving" + "Instruction"	273	
"Intuitive Decision Making" + "Instruction"		
"Naturalistic Decision Making" + "Instruction"		
"Recognition Primed Decision Making" + "Instruction"		
"Intuitive Judgement" + "Instruction"		
"Intuitive Problem Solving" + "Instruction"		

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4. Annotated Bibliography

Articles were assessed as high, medium or low relevance according to the degree to which they advanced the application of decision making theory in planning applications, and in particular their relevance to training of decision making skills. Papers which merely described decision making theory were generally of low relevance; those that specifically referred to decision making theory applied to the military planning process were generally of high relevance.

In addition, special editions of journals, conference proceedings (i.e. of the NDM conference series) and books are presented in their own section.

Particularly relevant portions of each abstract are formatted in ***italics***. Abstracts are reproduced verbatim from the original source.

4.1. High Relevance

Author: Allardice, R.R.
Year: 1998
Title: One Half a Revolution in Orientation Implications for Decision Making. - Master's thesis
Journal: Air War Coll., Maxwell AFB, AL
Pages: 55
Date: April
Abstract: The military is locked in a technology-driven orientation that designed great command and control systems for the cold war, but this same mentality is inadequate to address decision making challenges of the future. Consequently, the military must rebuild its intellectual framework to link decision makers to forces in an incredibly dynamic environment. The appropriate rebuilding is through a *decision-centred approach to command and control systems*. To adequately comprehend this approach, policy makers must understand how humans decide and how decision makers fit into complex systems. This study investigates current research on decision making and *links naturalistic decision making theory with complexity theory to provide a basis for analyzing decision support systems. Using Boyd's OODA loop as a frame of reference*, this paper describes how the post cold war orientation has changed decision requirements. Next, the study proceeds with a discussion on decision theory with thoughts on how recent progress in naturalistic decision making theory should fundamentally redirect decision system design. Complexity theory offers an opportunity to link the decision maker to other elements of a unit and provides a basis for advocating decision-centred methods to improve decision performance. The study concludes with comments and recommendations on current efforts to move toward decision centred design.
Notes: H

Author: Athens, A.J.
Year: 1992
Title: Unravelling the Mystery of Battlefield Coup D'Oeil
Journal: Ft Leavenworth, KS
Pages: 55
Date: Dec

Abstract: This monograph analyses current theories of intuitive decision making originating from the fields of psychology, cognitive science, political science, and management science. The monograph's objective is to determine whether these theories help explain the trait considered essential for success on the battlefield, coup d'oeil.
The monograph first synthesizes the thoughts on coup d'oeil as addressed by the preeminent military theorists. Next, it traces the development of research on intuitive decision making and how this research introduced a new decision making paradigm. Then the monograph uses a specific intuitive decision making model, the recognition-primed (RPD) to evaluate the battlefield decision processes of two commanders - British Field Marshall William Slim and Israeli Major General Avraham Adam. Analysis of these two commanders' memoires helps determine how well the RPD model captures the essence of decision making on the battlefield.
The monograph concludes that the current *thought on intuitive decision making provides significant insights into coup d'oeil*. Specifically, the discoveries in the areas of *situational assessment, sequential analysis of options, and mental simulation* of proposed courses of action, elucidate how rapid decision making under uncertainty and ambiguity occurs. Additionally, the monograph's historic analysis uncovered another key aspect of intuitive decision making, the *'decision framework'*. This framework includes the *numerous predispositions commanders bring to the battle*, allowing them to assess their situations quickly and narrow their choices. These observations imply the military should be aggressively educating their officers about intuitive decision making, thereby unveiling the keys to battlefield coup d'oeil.
Notes: H

Author: Fallesen, J.J.
Year: 1995
Title: Decision matrices and time in tactical course of action analysis
Journal: Military Psychology
Volume: 7
Issue: 1
Pages: 39-51
Abstract: *Tactical decision-making doctrine incorporates rules that conform to a classical additive weighting model*. However, *decision-making research has increasingly focused on naturalistic strategies*. An experiment was conducted to investigate classical and natural approaches to tactical analysis. Teams of U.S. Army officers used either unspecified or structured procedures to analyze courses of action. Structure was imposed by providing workbooks for individual task steps. Completion times and additive weighted matrices were included. Paper-and-pencil and computer versions of materials were used. Teams from both structured groups had better justification scores than those with unspecified procedures. Computer support provided no additional advantage. The more detailed consideration of battle events provided the desired influence, whereas the classical decision rules did not seem to. Early conclusions did not result in better or poorer performance. *The findings suggest modified rules for tactical analysis that emphasize detailed consideration of events and flexibility in the timing of decisions.*
Notes: H

Author: Fallesen, J.J., Michel, R.R., Lussier, J.W., Pounds, J.
Year: 1996
Title: Practical Thinking: Innovation in Battle Command Instruction
Pages: 122
Date: Jan
Report Number: ARI-TR-1037
Abstract: Instruction on practical thinking skills was developed and implemented in a Command and General Staff Officers course on Battle Command. A cognitive skills approach was emphasised as opposed to the traditional procedural models used in other Army education programs. The cognitive skills were identified from a study of tactical planning and decision making, review of civilian cognitive skill instruction programs, and the application of new models of naturalistic decision making. The *program consisted of 12 hours of instruction and six meetings*. Practical thinking consists of creative and critical thinking. It is based on natural ways of thinking such as considering multiple perspectives, adapting thinking to situations, looking for hidden assumptions, and following guidelines for reasoning. This report describes the General Officer tasking that led to the work, the *identification of requirements for practical thinking, description of lessons, experience with using the program, and recommendations* for further pursuit of improving practical thinking skills.
Notes: H

Author: Fallesen, J.J., Pounds, J.
Year of Conference: 1998
Title: Identifying and testing a naturalistic approach for cognitive skill training
Conference Name: Fourth Conference on Naturalistic Decision Making
Conference Location: Warrenton, Virginia
Pages: 10
Date: 29-31 May
Abstract: The purpose of this study was to understand better the actual problem solving strategies used by Army officers and to perform a *proof of concept test of a naturalistic-based approach to training*. The study was conducted in two phases. The first phase collected strategy usage and importance data from 48 company and field grade officers. A *focus for training* was identified from this first phase. In the second phase a *training lesson was tested* with 31 officers on which the same data as in phase I were collected using a pretest, training, posttest study design.
Notes: H

Author: Fallesen, J.J., Pounds, J.
Year: 2001
Title: Identifying and testing a naturalistic approach for cognitive skill training
Editor: Salas, E., Klein, G.A.
Book Title: Linking Expertise and Naturalistic Decision Making
City: Mahwah, NJ.
Publisher: Lawrence Erlbaum Associates
Pages: 55-70
Notes: H

Author: Kievenaar, H.A.
Year: 1997
Title: Accelerated Decision Making at the Task Force Level
Journal: US Army Command and General Staff College, Ft Leavenworth, KS.
Pages: 98
Date: June
Abstract: This study challenges the *military decision-making process as both ineffective and inefficient for use in decision making at the task force level*. FM101-5 (final draft) Staff Organisation and Operations, 1966, currently prescribes the MDMP as the only accepted process for decision making. This process is applicable to all echelons. This researcher suggests that the decision making process is different at task force level and makes recommendations to improve the decision making process when applied to the resource constrained environment characteristic of task force level operations. The MDMP is a systematic, analytical approach to decision making that generates multiple courses of action for the purpose of allowing the commander to select the optimum COA. This study explored the existing theories of naturalistic or RPD decision making for the purpose od determining a single option rapidly. The MDMP is by its own description a staff and time intensive process. *The requirement to develop the best possible solution instead of one workable solution results in a significant increase in time used in the conduct of the planning process with no applicable difference in the results*. The research examined the MDMP against the environment characteristics of task force level operations for efficiency and effectiveness. The study concluded that the MDMP is neither an efficient nor effective planning process when applied ot task force level. The *study provides recommended improvements for the MDMP to streamline the process and make it a more efficient and effective process for task force level planning. Key to the discussion is the idea of returning to a more commander involved mental process versus the present staff-driven, product oriented process of FM 101-5.*
Notes: H

Author: Klein, G. A., Calderwood, R.
Year: 1990
Title: Investigations of Naturalistic Decision Making and the Recognition-Primed Decision Model. - Research note
Pages: 61
Report Number: KA-TR-88-02Z; ARI-RN-90-59
Abstract: This monograph reviews 3 years of research that explores how experienced personnel make decisions in operational settings characterized by *real-time information processing, shifting goals, and high-risk consequences*. The study combined field studies with experiments designed to test specific hypotheses. Study domains were selected so that findings would have high potential for generalizing to military command-and-control decision making. Researchers carried out critical decision interviews with experienced personnel, including urban fire ground commanders, wildland fire incident commanders, and U.S. Army tank platoon leaders. Interviews were designed to elicit information about the cues, goals, and option evaluation strategies used by these personnel. Based on these interviews, the relationships among such factors as time pressure, experience level, and group interactions were explored. The results of these studies have been used to develop a *Recognition-Primed Decision (RPD) model of decision making. This model contrasts with current normative and prescriptive models* of decision making, and the

implications of this alternative framework are explored.
Notes: H

Author: Klein, G.A.
Year: 1997
Title: Developing Expertise in Decision Making
Journal: Thinking and Reasoning
Volume: 3
Issue: 4
Pages: 337-352
Abstract: How can people be helped in developing judgement and decision skills? One approach is to teach formal methods such as decision analyses, but these are *difficult to apply in ill-structured settings*, and the methods are unworkable when one is under *time pressure and uncertain conditions*. If one regards these skills as types of expertise that can be developed, then in a given domain one may attempt to *define the cues, patterns, and strategies used by experts*, and *develop a programme to teach people how to think like experts*. However, in many settings this can be impractical. A *different approach* to decision skills training is to *teach people how to learn like experts*. Identification of a *set of strategies* used by experts to develop their proficiency at decision making can aid in the development of a programme aimed at helping people become *reflective practitioners*. This article describes such a *training programme*.
Notes: H

Author: Klein, G.A., Thordsen, M.L. Calderwood, R.
Year: 1990
Title: Descriptive Models of Military Decision Making
Pages: 11
Date: Aug
Abstract: It is important to understand the nature of military decision-making strategies in order to plan for those systems dependent on their effectiveness. This paper reports the results of three studies examining team decision making in the Army. The data suggest that *recognitional decision making is much more common than analytical decision making*. The *strengths and weakness of recognitional and analytical decision strategies* are viewed and compared, and we describe *factors affecting the type of strategy used*. Finally, the use of recognitional strategies has implications for tactical planning, and the paper examines the *conditions under which different planning approaches are most effective*.
Notes: H

Author: Klein, G.A., Wolf, S.
Year of Conference: 1995
Title: Decision-Centered Training
Conference Name: Designing for the Global Village. Proceedings of the Human Factors and Ergonomics Society 39th Annual Meeting
Conference Location: San Diego, California
Pages: 1249-1252
Date: October 9-13
Abstract: What can the Naturalistic Decision Making (NDM) perspective tell us about training people to make better decisions? The NDM framework offers *four guidelines* for training: (i) *build expertise, rather than teaching generic analytical strategies, (ii) support,*

rather than replace, the strategies people use; (iii) make the decision requirements specific to the task context; (iv) model the cognitive processes of subject matter experts. Training can be implemented using *better scenarios* and through *cognitive modelling*. A recent project is described, in which decision-centred training was used at the National Emergency Training Centre to revise a set of course materials. The *revisions emphasized opportunities to improve situation awareness skills through better specification of critical cues and patterns, and recommendations about using debriefs following exercises to probe for cognitive processes underlying judgements and decisions.*
Notes: H

Author: Lipshitz, R., Strauss, O.
Year: 1997
Title: Coping with uncertainty: A naturalistic decision-making analysis
Journal: Organisational Behaviour and Human Decision Processes
Volume: 69
Issue: 2
Pages: 149-163
Date: Feb
Abstract: Examines how decision makers conceptualize, cope with, and systematically relate to different conceptualizations of uncertainty and coping strategies for uncertainty. A self-report instrument on decision-making under uncertainty with a method of classifying conceptualizations of uncertainty and coping mechanisms was developed from the decision-making literature. Results show that 102 undergraduate decision makers distinguished among *3 types of uncertainty: inadequate understanding, incomplete information, and undifferentiated alternatives. Five strategies of coping were also identified: reducing uncertainty, assumption-based reasoning, weighing pros and cons of competing alternatives, suppressing uncertainty, and forestalling. Inadequate understanding was primarily managed by reduction, incomplete information was primarily managed by assumption-based reasoning, and conflict among alternatives was primarily managed by weighing pros and cons.* Based on previous studies (e.g., L. R. Beach, 1990) of naturalistic decision-making, the authors hypothesize a *R.A.W.F.S. (reduction, assumption-based reasoning, weighing pros and cons, suppression, and hedging) heuristic*, which describes the strategies that decision makers apply to different types of uncertainty in naturalistic settings.
Notes: H

Author: Neville, K., Fowlkes, J., Strini, T.
Year: 2003
Title: Facilitating the Acquisition of Mission Planning and Dynamic Replanning Expertise. - Final rept. Feb-Aug 2002
Pages: 78
Date: July
Report Number: AFRL-HE-AZ-TR-2003-0016
Abstract: Two current trends *increasingly complex tactical teams* and the growing *demand for dynamic replanning* have significant implications for mission planning and the ways in which it can best contribute to mission success. Effective mission planning can facilitate team coordination both during the relatively predictable phases of a mission and during more challenging mission events that require dynamic replanning or decision making. However, it is hypothesized that aspects of *mission planning expertise that*

facilitate team coordination during dynamic replanning and decision making are not exactly the same as those that support team coordination during more predictable mission phases. On the basis of this assumption, we proposed to develop the *Cognition- Centred Constructivistic Program of Instruction (C3PI)* as a means of facilitating the acquisition of those aspects of mission planning expertise that contribute specifically to the ability of a team to respond to dynamic, on-the- fly types of mission events. This Phase I effort involved research and development conducted for the purpose of developing a C3PI system design that is grounded in theory and research and consistent with the training needs and constraints of the operational user community.
Notes: H

Author: Oser, R.L., Gualtieri, J.W., Cannon-Bowers, J.A., Salas, E.
Year: 1999
Title: Training Team Problem Solving Skills: An Event-Based Approach
Journal: Computers in Human Behaviour
Volume: 15
Issue: 3-4
Pages: 441-462
Abstract: Training problem solving teams presents a unique set of challenges to instructional designers. Given the criticality of teams to the performance of many organizations, it is important to develop training systems to support coordination and problem solving. While recent technological advancements, such as computer-based performance assessment, hold considerable promise for training, the introduction of technology alone does not guarantee that the training will be effective. This article focuses on *three important questions that must be addressed when developing coordination and problem solving training: (1) How can technology best be used to provide an environment in which learning can take place? (2) What knowledge, skills, and attitudes need to be learned and trained to facilitate expert problem solving teams? and (3) How can the development of problem solving expertise be fostered through a systematic instructional strategy*? A naturalistic decision making paradigm is used to provide a theoretical framework for describing the problem solving task domain. An *event-based approach to training is then offered as a practical application for training teams to perform in naturalistic environments*. Finally, conclusions are drawn regarding the provided framework for team learning.
Notes: H

Author: Rieksts, D.H.
Year: 1997
Title: "Gut Feel": Recognition Decision Making and the Operational Commander
Pages: 22
Date: Feb
Abstract: In a world where decision making is increasingly dominated by technology and analysis, the concept of decision making by 'gut feel' may be regarded by some as an anachronism. Yet, others contend that technology and modern warfare have made *analytical decision making ponderous and inflexible*. More than ever, *commanders will need to rely on their judgement and intuition*. This paper examines the role of intuition and its relevance to today's military decision making at the operational level. It discusses the behavioural concepts of intuition and the relationship between intuition, military doctrine and theory. Finally, *a decision making process utilising many of the concepts*

developed in the paper is offered as an alternative to the estimate planning process.
Notes: H

Editor: Salas, E., Klein, G.A.
Year: 2001
Title: Linking Expertise and Naturalistic Decision Making
City: Mahwah, NJ
Publisher: Lawrence Erlbaum Associates
Abstract: A lot of potentially useful papers in this book.
Notes: H

Author: Van Den Bosch, K., Helsdingen, A.S.
Year of Conference: 2002
Title: Improving Tactical Decision Making through Critical Thinking
Conference Name: Bridging Fundamentals and New Opportunities. Proceedings of the 46th Annual Meeting of the Human Factors and Ergonomics Society
Conference Location: Baltimore, Maryland
Pages: 448-452
Date: September 30-October 4
Abstract: *Expert military commanders construct an initial but comprehensive interpretation of complex or unfamiliar tactical situations (story). They subsequently adjust and refine this story by evaluating available information, by searching for consistency, and by critically testing underlying assumptions.* This approach is used to develop *critical thinking training*. Two effect studies were conducted. Individual commanders (study 1) and commanding teams (study 2) played scenario-based exercises in both simplified and high-fidelity task environments. Half the group received instruction, guidance, and feedback in critical thinking. The other half received the same scenarios, but without any support. After training, test scenarios were administered to both groups. Results showed *positive effects on the process of tactical command* (i.e. better argumentation for situation assessment), *as well as on the outcomes* (i.e. more and better contingency plans). The method supports not only individual commanders, it also helps teams to develop a common understanding of the situation and to co-ordinate team actions.
Notes: H

Editor: Zsambok, C.E., Klein, G.A.
Year: 1997
Title: Naturalistic Decision Making
City: Mahwah, NJ
Publisher: Lawrence Erlbaum
Abstract: Lots of relevant papers in this book.
Notes: H

4.2. Medium Relevance

Author: Adams, R.J.
Year: 1993
Title: How Expert Pilots Think - Cognitive Processes in Expert Decision Making
Pages: 81
Date: Feb
Report Number: DOT/FAA/RD-93/9
Abstract...Since the speed and accuracy of expert cognitive processes make them take on the characteristics of insight or intuition, the role of intuition in decision making is the next analytical part of the investigation. *Intuition is defined and the properties of intuition relevant to EDM delineated....*
Notes: M

Author: Bonifay, B.F.
Year: 2000
Title: Is it Time to Use the Right Side of Our Brain. A Comparison of Analytical and Naturalistic Decision Making Processes. - Final rept
Journal: Naval War Coll., Newport, RI
Pages: 20
Date: Feb
Abstract: As commanders, how do we make decisions. In scientific theory, there are two methods or models for the decision-making processes - the Analytical Decision-Making (ADM) model and the Naturalistic, or Recognitional, Decision- Making (NDM) model. The time one has to make a decision within a certain situation will influence the decision making process. *With the factor of time most prevalent in this situation, a greater emphasis should be placed on intuitive decision-making processes.* In developing intuition, *commanders can gain a supportive experience base by immersing themselves in numerous decision- making situations.* Over time, *simulations expand a commander's pattern recognition ability thus improving his intuitive decision making skills. In a final analysis, the operational commander makes decisions dependent on the situation he is facing.* I contend that commanders of today and future commanders need to understand and incorporate the intuitive Naturalistic Decision-Making process. The intuitive decision-making inherent in the Naturalistic Decision-Making process provides a sound basis for determining a proper course of action for a given situation. This paper is not designed to espouse that analytical decision-making processes be forgotten, but illustrates that every decision is determined by a situation.
Notes: M

Author: Brecke, F.H., Garcia, S.K.
Year: 1995
Title: Training methodology for logistic decision making
Pages: 94
Date. Oct
Report Number: AL/HR-TR-1995-0098
Abstract: Describes the *development of instructional strategies for training complex decision-making skills to Logistics Command and Control personnel.* The need exists for more accessible, more affordable, and less manpower-intensive training. The objective of

the research is to develop an experimental desk-top-computer-based training prototype that combines decision making lessons with simulation environments to enable logistics personnel to experience the same kinds of problems and situations encountered in the operational environment. To this end, a series of models was developed that describes the nature of the decision-making task, the process of uncertainty reduction, and the process of learning decision-making skills. Instructional design guidelines were deduced from the models and other sources. The guidelines were then applied to the training problem, and an organizational strategy for the desktop training system was developed.
Notes: M

Author: Brezovic, C. P., Klein, G.A., Thordsen, M
Year: 1990
Title: Decision Making in Armored Platoon Command
Pages: 119
Date: July
Report Number: KA-TR-858(B)-05F
Abstract: This research studied command decisions during armoured platoon leader training exercises. The Critical Decision method was employed to identify command decisions and the environmental features of decision situations offering a command challenge to the students. The student platoon leader, the trainer evaluating his performance, and one researcher all rode the platoon leader's tank and observed the events from the same perspective. A total of 57 decision points were identified and probed. The interviews collected direct contrasts between the more experienced trainer and the new student for the analysis of decision situations and factors affecting decision making. The students deliberated during option selection in approximately half of the decisions. The students also *reported relying on analogues to select their choice of options in close to half of the decisions, but the use of analogues ranged from helpful to disruptive in resolving decision situations*. Option deliberation and analogue use as strategies in decision making by the novices were more frequent than in previous work with more experienced decision makers. *Poor performance by the students was consistent with their inability to imagine hypothetical situations*, such as enemy actions and the relationship between friendly and enemy tactics. The findings suggest that performance errors were due not to a limited ability to monitor situational cues but to the misinterpretation of the cues. The results were contrasted to traditional decision-making literature. *Training methods were recommended that would incorporate the implications of the study findings.*
Notes: M

Author: Dejarnette, J.C.
Year: 2001
Title: Keeping Your Dog in the Fight: An Evaluation of Synchronization and Decision-Making
Journal: School of Advanced Military Studies, Command and General Staff College, Ft Leavenworth, KS
Pages: 47
Abstract: This monograph examines the relationship between battlefield synchronisation and decision-making. Beginning with a review of rational analytical decision theory and Gary Klein's RPD theory, the monograph reviews the Military Decision Making Process (MDMP) to determine *if the MDMP and its resultant products are sufficient to achieve and*

maintain synchronisation of the effects of distributed operations. In addition to the detailed review of the MDMP, the monograph considers the relationship between complexity, uncertainty and synchronisation.
Klein's RPD theory, based on extensive study of fire fighters, emergency medical workers and military commanders describes the intuitive manner which experienced people most frequently use to solve problems. When employing RPD techniques, *decision-makers filter environmental cues and create a solution hypothesis using an analogy or a metaphor.* This hypothesis is then *tested using mental simulation to ensure it is acceptable. RPD is very effective when the decision maker has substantial expertise in solving the type of problem at hand, however it is adversely affected by uncertainty, ambiguity and complexity. RPD seeks satisfactory, rather than optimal, solutions.*
Rational analysis is a common *alternative to RPD*, seeking optimal solutions through deliberate, detailed analysis. Rational analysis provides the theoretical underpinnings of the MDMP. *Rational analysis is a linear procedure used to solve complex, interdisciplinary problems that exceed the expertise of any single decision-maker.* Rational analysis is a *time consuming* process because of the sequential nature of analysis and decision. Because it is a *group process* it is *vulnerable to errors* of miscommunication and misperception. However, rational analysis and RPD are *complementary approaches* to problem solving because rational analysis can generate synthetic experience to support RPD based decisions.
The MDMP is doctrinally described as a rational analysis process. MDMP is a time consuming, sequential process that generates solutions through strict adherence to procedure. *MDMP does not support effective synchronisation of effects because its linear, sequential approach inhibits a holistic solution to problem solving.* Further, the products generated during the MDMP do not adequately address the identification of the decisive point and supporting the adjustment decisions required to maintain synchronisation in the dynamic environment of combat.
This monograph concludes that the MDMP and RPD are complementary processes. It establishes that synchronisation must be injected into MDMP during mission analysis, rather than during course of action analysis. It recommends that modifications to the MDMP to emphasise decision support products and changing the MDMP from a strictly linear, sequential model to a feedback-based iterative procedure.
Notes: M

Author: Dror, I.
Year: 2002
Title: Enhancing Decision Performance
Institution: University of Southampton
Pages: 41
Date: 17 Jul
Report Number: F61775-01-W-E039
Abstract: This report results from a contract tasking University of Southampton as follows: The contractor will *investigate the link between knowledge acquisition (via training) and usability (via testing), as well as between the stage of planning and decision-making and the stage in which plans & decisions are executed.* Experiments will investigate how people internalize and represent information, and how this influences their subsequent ability to use that information. Results will focus on the ability to generalize beyond examples used during training, the ability to use and incorporate new information,

the capacity to be flexible, and the ability to develop creative solutions dictated by changing task demands under high information load and time pressure.
Notes: M

Author: Jacobs, P.A., Gaver, D.P.
Year: 1998
Title: Human Factors Influencing Decision Making
Pages: 96
Date: July
Abstract: this report supplies references and comments on literature that *identifies human factors influencing decision making, particularly military decision making*. The literature has been classified as follows (the classes are not mutually exclusive): *features of human information processing; decision making models which are not mathematical models but rather are descriptive; non-personality factors influencing decision making; national characteristics influencing decision making; personality factors influencing decision making; decision making in a military organisation.*
The decision maker is influenced by many factors both internal to the decision maker and external to him/her. The environmental context in which a decision is made makes it difficult to associate personality traits with specific decision making behaviour. Internal factors that influence decision making include limited information processing and memory capabilities. These limitations can result in biases in processing information such as anchoring (undue weight for evidence supporting the initial hypothesis) or recency (undue weight on more recent evidence). The limitations can also result in decision making heuristics. Training and experience can lessen the effects of limited information processing and memory capabilities.
The first part of the report is a summary of the findings of the literature survey. This is followed by detailed endnotes concerning the references.
Notes: M

Author: Klein, G.A.
Year: 1997
Title: Implications of the Naturalistic Decision Making Framework for Information Dominance. - Interim rept. Jan-Sep 97
Pages: 62
Date: July
Report Number: AL/CF-TR-1997-0155
Abstract: This report explores the implications of the Naturalistic Decision Making (NDM) framework for the domain of Information Dominance, defined as an operational advantage obtained through superior effectiveness of informational activity. NDM is the *study of how people use their experience to make decisions in field settings*. Expertise was considered at both the individual and the team level of decision making. The report *defines the components of expertise and identifies obstacles to the acquisition of Information Dominance. These obstacles include: (1) excessive data, (2) pre-processed data, (3) excessive procedures, (4) performing formal analyses, (5) passive data handling and limited ability for information seeking, and (6) interfaces that obscure the big picture*. The danger exists that these obstacles will severely limit the use of expertise at the individual and the team level, and that information technology will result in reduced rather than increased performance. The application of the NDM perspective demonstrates how information technologies can interfere with expertise, and provides assistance in the

development of procedures which ensure that information technologies support Information Dominance functions. Directions for future research into the nature of the obstacles are identified.
Notes: M/H

Author: Klein, G. A., Calderwood, R.
Year: 1996
Title: Investigations of Naturalistic Decision Making and the Recognition-Primed Decision Model. - Final rept. Jul 85-Jul 88
Pages: 127
Date: Mar
Report Number: ARI-RN-96-43
Abstract: This monograph reviews 3 years of research concerned with how experienced personnel make decisions in operational settings characterized by real-time information processing, shifting goals, and high-risk consequences. The study method combined field studies with experiments designed to test specific hypotheses. Study domains were selected so that findings would have high potential for generalizing to military command-and-control decision making. Critical decision interviews were carried out with experienced personnel, including urban fire ground commanders, wildland fire incident commanders, and U.S. Army tank platoon leaders. Interviews were designed to elicit information on the cues, goals, and option evaluation strategies used by these personnel. *Based on these interviews, the relationships among such factors as time pressure, experience level, and group interactions were explored.*
Notes: M/H

Author: Klein, G., Crandall, B.
Year: 1996
Title: Recognition-Primed Decision Strategies. - Final rept. Nov 88-Nov 91
Pages: 55
Date: Mar
Report Number: ARI-RN-96-36
Abstract: We describe activities conducted during a 3-year basic research contract that has its goal extension and examination of a Recognition-Primed Decision (RPD) model of decision making. *The RPD model describes a decision strategy commonly employed by proficient personnel called upon to make decisions in operational settings by high risk, time constraints, and ambiguous or incomplete information.* Work was organized around three areas of interest: (1) *evaluation of the relative strengths and weaknesses of the RPD strategy, (2) examination of the nature of simulation assessment in C2 environments, and (3) exploration of techniques for supporting decision making in operational environments that are consistent with the RPD framework.* The report contains descriptions of nine studies (seven empirical, two analytical) conducted to examine these issues. One important outcome of the research has been to advance understanding of the role of mental simulation in decision making. We have developed a detailed mode of mental simulation, including an account of how mental simulation serves as a source of power for a variety of cognitive functions. Work performed under this contract has helped to establish naturalistic decision making as an important and unique perspective.
Notes: M/H

Author: Klein, G.A., Zsambok, C.E.
Year of Conference: 1991
Title: Models of Skilled Decision Making
Conference Name: Visions. Proceedings of the Human Factors Society 35th Annual Meeting
Conference Location: San Francisco, California
Pages: 1363-1366
Abstract: How do people learn to make better decisions? The authors believe people *use their experience* to make better judgements and decisions, and that it is the *accumulation and application of an experience base that is the key*, rather than the use of more powerful strategies. If we are to provide meaningful training, we must understand the role of experience in decision making. In this paper the authors first examine the role of experience in classical models of judgement and decision making. Next they describe the role of experience in naturalistic decision models. They are particularly interested in the way people use their experience to handle time stress, ambiguous/incomplete and unreliable data, and ill-structured tasks. Finally, the authors present *implications for training people to make better judgements and decisions.*
Notes: M

Author: Kobus, D.A., Proctor, S., Holste, S.
Year: 2001
Title: Effects of Experience and Uncertainty during Dynamic Decision Making
Journal: International Journal of Industrial Ergonomics
Volume: 28
Issue: 5
Pages: 275-290
Abstract: The decision response times in dynamic tactical scenario in which participations interacted with a virtual command-post environment were investigated. Fifty-two Marines with varying amounts of command-post experience assessed the situation as it developed, determined tactical leverage points, formed a plan of action, and submitted battle orders. Two scenarios were studied - each differed in the level of certainty in the information provided. The tactical decision process was modelled and analyzed in the following sequential, cognitive stages: situation assessment, course of action selection, course of action execution. Results show that the time required to assess the situation was significantly longer (p<0.05), for the high-experience group than the low-experience group. However, once the assessment was complete, the selection of a course of action (COA) was significantly faster for the high-experience group than the low-experience group. In addition, COA selection under conditions of low certainty was significantly longer than under conditions of high certainty. Time required for COA execution indicated a significant main effect of experience (p<0.05), a main effect of task certainty approaching statistical significance (p=0.067), and statistically significant interaction (p<0.05). These results indicate that *the time needed to execute the COA, once determined, is significantly less for the highly experienced individuals under conditions of low certainty. However under the conditions of high certainty, no statistically significant time differences were found based upon the experience level. The high-experience group was significantly more accurate than the low-experience group for developing an appropriate COA.*
Notes: M

Author: Livsey, T.D.
Year: 1992
Title: Teaching Tactical Decision Making: What is Important?
Journal: School of Advanced Military Studies, Command and General Staff College, Ft Leavenworth, KS.
Pages: 53
Date: Dec
Abstract: This monograph determines if the Command and General Staff College (CGSC) is educating officers as tactical decision makers who can think. It establishes a *framework for what is important for tactical decision making*. The four elements fo the framework include *the principles of war, tactical decision making, building experience and mental agility*. This framework is developed from researching current Army doctrine and military theory to demonstrate their contemporary relevance to tactical decision making. After establishing the current and historical significance of these elements to tactical decision making, they are used as criteria to evaluate the core tactics program of instruction (POI) at CGSC. The assessment is derived from data obtained from interviews with the faculty and staff, from the Centre for Army Tactics (CTAC), and a review of CGSC students issue material from the core tactics POI. This data is compared against research from the framework to determine if CGSC is teaching what is important to tactical decision making.
This monograph *concludes that the principles of war, tactical decision making, building experience and mental agility are prominent aspects of tactical decision making*. They are essential for officers that must think about the diverse challenges facing the Army. The assessment of the core tactics POI *concludes that these four essential aspects of tactical decision making are not integrated in the core tactics POI taught at CGSC*.
Notes: M

Author: Marr, J.J.
Year: 2001
Title: Military Decision Making Process: Making Better Decisions Versus Making Decisions Better. - Monograph rept
Journal: Army Command and General Staff Coll., Fort Leavenworth, KS. School of Advanced Military Studies
Pages: 81
Date: Jan
Abstract: This monograph examines the Military Decision-Making Process (MDMP) as presented in the 1997 version of FM 101-5, Staff Organization and Operations. *Numerous military professionals and decision-making theorists hold that an analytical process such as the MDMP is inappropriate for tactical operations*. Officers supporting this line of reasoning suggest that the *tempo and uncertainty of the brigade/battalion fight calls for an intuitive decision- making process*. Through a detailed analysis of what the MDMP is theoretically designed to accomplish, this monograph provides *evidence to counter this criticism*. The structure of the paper provides this evidence by first establishing the validity of using an analytical model in the tactical environment, and then demonstrating that the MDMP is the right analytical model. The first part of the paper, an examination of the MDMP in the context of problem-solving theory, suggests that *an analytical planning process is needed to support future intuitive decisions*. This justifies the use of the use of the MDMP's analytical processes, answering the first question. The second part of the

paper determines *whether the MDMP is the right analytical model*. The paper accomplishes this by examining the MDMP against two sets of criteria. The first set, are *planning imperatives suggested by historical doctrine*. The second set represents the *psychological processes that human decision-makers need to overcome the combined friction of the tactical environment*. Together, these two sets of criteria explain how the *MDMP is an appropriate analytical model*, which answers the second question. This monograph suggests that *command and control at the tactical level represents a system where analytical planning is necessary for successful intuitive decision-making*. The MDMP meets the U.S. Army s institutional expectations, represented by.
Notes: M/H

Author: McCann, C., Baranski, J.V., Thompson, M.M., Pigeau, R.A.
Year: 2000
Title: On the utility of experiential cross-training for team decision-making under time stress
Journal: Ergonomics
Volume: 43
Issue: 8
Pages: 1095-1110
Date: Aug
Abstract: Investigated the effectiveness of experiential cross-training in a team context for team decision-making under time stress in a simulated naval surveillance task. It was *hypothesized that teams whose members explicitly experience all team positions will perform better under time pressure, and it was posited that experiential cross-training would reduce the negative effect of member reconfiguration that can occur in certain military situations*. Three groups of teams (cross-trained [CT], reconfigured and control) were involved in 3 team training sessions, followed by 3 time-stressed exercise sessions. During training, one group was cross-trained by asking each member to perform an entire session at each of the 3 team positions. Member reconfiguration (where each member was shifted to another's position) was introduced at the first of the exercise sessions for the CT group and for the non-CT reconfigured group. *The control group was neither cross-trained nor reconfigured. During training, the performance of non-CT teams improved more quickly than that of CT teams*. During the exercise, the *CT group did not achieve the level of performance of the control teams*. The immediate *effect of team member reconfiguration was to degrade performance significantly for the non-CT teams*.
Notes: M

Author: Phillips, J., McCloskey, M.J., McDermott, P.L., Wiggins, S.L., Battaglia, D.A., Thordsen, M.L., Klein, G.A.
Year: 2001
Title: Decision Centred MOUT Training for Small Unit Leaders
Pages: 109
Date: August
Report Number: Research Report 1776
Abstract: This research effort *applied principles of NDM to identify the cognitive challenges involved in platoon leader decision making in military operations in urban terrain (MOUT) building clearing missions*. The findings informed the development of classroom, hardcopy, and multimedia training products to support Infantry Officer Basic Course students in MOUT decision making. A CTA of the building clearing task entailed a

series of in-depth interviews with Army personnel experienced in MOUT. The analysis resulted in a detailed representation of 11 high level decision requirements associated with the building clearing task. Cognitive demands related to each requirement - critical decisions and judgements, sensory cues, other factors, and expert strategies - are included in the representation. *Four products were developed based on the findings of the analysis: sixteen decision centred training scenarios for MOUT environments; an interactive multimedia tool (IMPACT) that supports instructors in training MOUT decision making skills; a classroom exercise that supports situation awareness appreciation and understanding; and a guide that provides supplemental information regarding the building clearing task from a platoon leader's perspective.*
Notes: M/H

Author: Pliske, R., McCloskey, M., Klein, G.A.
Year of Conference: 1998
Title: Facilitating Learning from Experience: An Innovative Approach to Decision Skills
Conference Name: Proceedings of the Fourth Conference on Naturalistic Decision Making
Conference Location: Warrenton, Virginia
Pages: 7
Date: May 29-31
Abstract: The authors have developed an innovative approach to training recognitional decision making and have used this approach to train Marine squad leaders and firefighters. Based on evaluations made by the participants and their supervisors, this training appears to be an effective way to facilitate the development of recognitional decision making skills. Unlike traditional approaches which have attempted to teach generic decision-making strategies like decision analysis, the authors' approach *provides participants with simulation exercises and a set of training tools to increase the amount learned from these simulations.* The training tools include both pre- and post-training exercises to focus the participants' attention on the cognitive challenges involved in the simulation. *The pre-training exercises identify the cognitively challenging aspects of the simulation. The post-training exercises focus on the critical judgements and decisions made during the simulation and how uncertainties were managed.* The authors are currently modifying and extending this approach to decision skills training to train new cohorts of Marine squad leaders, and are also integrating parts of this training into the curriculum for both officers and enlisted personnel at the Marine Corps University.
Notes: M

Author: Pounds, J.F.
Year: 1998
Title: Problem Solving of Mid-Career Army Officers: Identifying Natural Reasoning
Institution: Human Resources Research Organisation
Pages: 40
Abstract: Military officers face diverse problems on the battlefield, during training, and in garrison. Doctrine specifies stepwise procedures as guidance for problem solving. However, these models are often not appropriate for varying circumstances. Further, other research (Pounds & Fallesen, 1997) demonstrated that these *models do not represent methods actually used by tactical leaders.* This project focussed on identifying officers' actual problem solving processes. Phase One of this project identified how situational variables affected officers' approaches to problems. Phase Two elaborated on the

influence of familiarity on strategy use. Strategy use was also examined related to conflicting tactical goals of force protection and mission accomplishment. *Although most participants stated that the strategy of identifying a specific goal was important to their thinking, a content analysis of interview transcripts revealed that the specific goals identified were of very diverse content.* Examination of transcripts also revealed a variety of new naturalistic strategies and *organizing themes*. These were defined and illustrated by examples. Recommendations are made for self-development and personal awareness to leverage existing knowledge to cope with novel situations.
Notes: M

Author: Pounds, J. F., Fallesen, J. J.
Year: 1994
Title: Understanding Problem Solving Strategies. - Final rept. May 93-Aug 94
Pages: 100
Date: Nov
Report Number: ARI-TR-1020
Abstract: The way in which problems are solved can have a dramatic impact on success. This report discusses the role strategies have in thinking processes, metacognition, planning, expertise, and decisions. The report also provides a description of each of 66 strategies identified in psychological studies. The *strategies have been grouped into three classes with three subordinate categories each*. The classes of strategies are *managing information, controlling progress, and making choices. The categories include considering hypotheses, combining information, managing the amount of information, ordering processes by hierarchical structures, sequencing processes, ordering processes by merit, managing the number of options, using compensatory choice, and using noncompensatory choice*. The report discusses the adaptive nature of strategies and how this information can be used to improve military problem solving. Notably, strategies have a specific contribution to make in the study of expertise, in defining decision aid requirements and in developing training programs. The principal conclusion was that existing definitions of strategies under-represented everyday problem situations and that actual strategies need to be observed, defined, and assessed for improvement. A general plan of research is outlined for improving military problem solving. (AN).
Notes: M

Author: Prince, C., Salas, E.
Year of Conference: 1997
Title: The Role of Situation Assessment in the Conduct of Flight and in Decision Making
Editor: Harris, D.
Conference Name: Engineering Psychology and Cognitive Ergonomics
Publisher: Ashgate
Volume: Volume One: Transportation Systems
Number of Volumes: 2
Pages: 291-297
Abstract: Within the context of normal flight, *situation assessment must occur continuously to ensure situation awareness*. In addition, according to naturalistic decision making models, *when a decision event arises, situation assessment must serve the decision process*. Situation assessment has been defined and described as it contributes to each of these two domains. This paper presents the two conceptualizations of situation assessment and highlights similarities and differences between them in order to achieve

increased understanding of the concept. A proposal is made to consider these two domains in relation to one another when situation assessment is being addressed, particularly for training. Specifically, the concept of nesting is proposed to help in integrating situation assessment requirements from the two domains and in applying this knowledge to training system design. *Examples of suggestions for training design are provided.*
Notes: M

Author: Russell, R. C.
Year: 2003
Title: In Support of Decision Making. - Monograph rept
Pages: 55
Abstract: This monograph investigates the art and science of problem solving and decision making in the operational planning environment. The Army's current problem solving and decision making doctrine found in FM 5-0 (101-5) Army Planning and Orders Production (Final Draft) provides one simplistic process and lacks information in the art of problem solving for planners and decision makers to follow. This research investigates the theory of problem solving and compares proven problem solving processes used and accepted in the business community with the Army's problem solving and decision making process. The research identifies components common to the processes analyzed, establishing goals or end state objectives, gathering information, and assessing implementation, which generally present challenges to the planner, and suggests methods to facilitate definition and communicate findings. The problem solving and military decision making process contained in the Army's doctrine serves as a sufficient beginning point for planning at the tactical level; however, due to rigidity and a lack of examples in problem solving theory, it is not sufficient when dealing with operational level problems. The *Army's process contains significant shortcomings for planners at the operational level because it does not address the theory of problem solving and lacks sufficient background of key components of the process - goal setting, information gathering, and implementation assessment.* This research concludes with recommendations to improve the Army's doctrine. It suggests the Army modify its existing problem solving and decision making doctrine to address additional relevant processes that are effective in a time constrained environment and when dealing with complex problems.
Notes: M

Author: Stallings, P.A.
Year: 1992
Title: What To Do, What To Do? Determining a Course of Action at the Operational Level of War
Journal: Army Command and General Staff College, Fort Leavenworth, KS, School of Advanced Military Studies
Pages: 192
Date: May
Abstract: This monograph examines the *adequacy of doctrinal decision making procedures for the operational level of war.* These doctrinal procedures are found in emerging joint doctrine. For these procedures to be adequate, they should: *provide a rigorous organization of thought and action; create and common, joint approach to decision-making; save valuable planning time; and increase probability of success on the battlefield.* The focus of research is on the actions taken from receipt or recognition of a

mission to the commander's selection of a course of action. To examine the question of whether an adequate process currently exists, I first briefly describe the tactical decision-making process, emphasizing its techniques for tying tactical concepts into a systematic analysis framework. I then survey both Army and Joint Staff manuals concerned with operational decision-making to determine if a process exists, and how that process compares to the tactical process relative to the adequacy criteria. From these comparisons, *I conclude that while a systematic analysis model for operational decision-making exists in emerging joint doctrine, the operational decision making model does not adequately integrate operational concepts for consideration by staff and commanders. They recommend a format based on the tactical process.*
Notes: M

Author: Whitehurst, S.
Year: 2002
Title: Reducing the Fog of War: Linking Tactical War Gaming to Critical Thinking
Journal: Army Command and General Staff College, Fort Leavenworth, KS, School of Advanced Military Studies
Pages: 55
Abstract: Based upon observations from the Combat Training Centres, *military staffs are ineffective at tactical war gaming* and thus the war game rarely contributes to effective decision-making. While war gaming is generally recognized as a weakness among many military staffs, many have concluded that the problems with the tactical war game reside in the participants lack of training or not understanding planning doctrine. This monograph does not accept this conclusion and explores, instead, the system itself. The purpose of this monograph is to find flaws not only in the 8-Step War Game Model but in the MDMP itself that contribute to ineffective war gaming. Additionally, this monograph recommends changes to the MDMP and war gaming that will make it a better tool that takes advantages of how expert decision makers think and plan. *This monograph establishes that the war game and to a certain extent, the MDMP, are ineffective because their focus reflects a linear approach to decision making that attempts to remove uncertainty from planning by developing multiple courses of actions (COAs), and then selecting the best COA based upon established criteria.* The opposite to a linear approach to decision making, is a non-linear approach that accepts battlefield uncertainty as a constant and focuses on managing uncertainty, rather than eliminating it. This monograph then argues that *the true power of war gaming comes from its potential as a non-linear decision making tool*. Next, this monograph demonstrates that the tactical war game never realizes its potential because of the tension that is created from trying to war game multiple COAs. Additionally, *this linear approach is counterproductive to group decision-making because it encourages groupthink*, a common pitfall of group decision-making.
Notes: M

Author: Zsambok, C.E., Klein, G.A., Kyne, M.M., Klinger, D.W.
Year: 1992
Title: Advanced Team Decision Making: A Developmental Model
Pages: 27
Date: Aug
Abstract: This document describes *Advanced Team Decision Making*: A Developmental Model (*ATDM*). Based on our observations of numerous tactical and strategic decision making teams, and on a review of relevant literature, Klein associates derived three key

components of advanced team decision making: *team self identify, team conceptual level, and team self monitoring*. The model contains *ten key behaviours critical to team development* in these components.
We developed this document for the Industrial College of the Armed Forces (ICAF). It describes the ATDM model in language compatible with the needs of ICAF students, who are being trained to transition into strategic-level leadership positions.
ATDM was first introduced in ICAF's 1992 curriculum. This document is the second of three components of the team training program Klein Associates designed for ICAF. The first component is an introductory lecture about ATDM (called "lesson 11" in this document) that we delivered to the faculty and student body. The third component (called "lesson 13") is an exercise designed for experiential learning. The exercise and facilitated after action review sessions give students an opportunity to practice, discuss, and improve their team decision making skills in a manner consistent with the ATDM model.
Notes: M

4.3. Low Relevance

Author: Andersen, J.A.
Year: 2000
Title: Intuition in managers: Are intuituve managers more effective?
Journal: Journal of Managerial Psychology
Volume: 15
Issue: 1-2
Pages: 46-67
Abstract: Do managers have the creative and innovative ability needed for their organisations to survive in an increasingly competitive environment? A study of 200 managers from eight companies gives an answer to this question. If intuition is an indication of creativity and innovation, we find that almost *25 per cent of all managers were primarily intuitive when solving problems and making decisions*. The concept of intuition and other decision functions is based on C. Jung's typology. Is intuition in managers an important asset to their organisations? An investigation of problem-solving and decision-making styles of 33 managers related to organisational effectiveness throws some light on this question. What is called the "creative-innovative" decision-making style was found in 23 percent of the managers. This article suggests that *intuition as decision-making style appears to be related to organisational effectiveness*. Several managers are intuitive. Whether the intuitive managers are more effective than others remains to be seen.
Notes: L

Author: Burwell, D.W.
Year: 2001
Title: Logical Evolution of the Military Decision Making Process. - Monograph
Journal: Army Command and General Staff Coll., Fort Leavenworth, KS. School of Advanced Military Studies
Pages: 56
Date: May
Abstract: This monograph explains the ability of the military decision-making process to inform the decision-maker in the current operational environment. A comparison of the

operational environment, as envisioned through the U.S. Army s doctrine, before and after the end of the Cold War establishes the framework by which commanders make decisions. Moreover this comparison highlights the critical changes in that environment that the MDMP has yet to account for. Next, an analysis of naturalistic decision-making theory provides insight into how commanders inform the decisions they make. Subsequently, the military decision- making process (MDMP) is analyzed to determine *the advantages and disadvantages of the process as compared to the current operational environment and the way experienced commanders naturally make decisions*. This analysis establishes the logical evolutionary steps the MDMP must make in order to be a viable decision- making process in the current operational environment The fundamental dilemmas of decision-making within the U.S. Army are five fold. First, there currently is little experience within the U.S. Army at the operational level. Yet, since the end of the cold war the U.S. Army is increasingly becoming involved at the operational level of war, as the shift in focus of the Army s doctrine indicates. Second, Joint Doctrine does not prescribe a methodology for decision- making that is fundamentally different from the tactical MDMP contained in U.S. Army doctrine. Because of the deficiency in Joint Doctrine it is logical that a U.S. Army planner, for example, operating in a Joint Task Force (JTF) headquarters will utilize the only decision-making process that the planner is familiar with the MDMP. Yet the MDMP is a tactical process. Third, the MDMP was a tactical decision-making process designed for the pre-cold war, tactical U.S. Army.
Notes: L/M

Author: Chapman, T., Mills, V., Kardos, M., Stothard, C., Williams, D.
Year: 2002
Title: Use of the Janus Wargame Simulation to Investigate Naturalistic Decision-Making: A Preliminary Examination. - Technical rept
Journal: Defence Science and Technology Organisation, Salisbury (Australia). Systems Sciences Lab
Pages: 70
Date: Dec
Abstract: The *Janus wargame was assessed as a means of investigating naturalistic decision-making (NDM)*. A further aim was to establish the generality of previous research that uses non-military simulation. Participants were divided into hierarchically structured teams of 3 (one military team, and three civilian teams). Each team was tested using open and restricted communication architectures. In line with predictions, open communication was more effective than restricted communication. In addition, military personnel out-performed civilian participants. No linear or quadratic patterns were found regarding the development of expertise. It was concluded that Janus was an effective means of examining NDM. In addition, the data indicated that non military simulation can generate valid data in relation to communication architectures, but not in relation to the development of military expertise.
Notes: L

Author: Cook, M., Elder, L., Ward, G.
Year: 1998
Title: Training Group Performance for Biasing and Debiasing Decision Making Which Avoids Groupthink
Institution: Collaborative Crew Performance in Complex Operational Systems. North Atlantic Treaty Organization, Research and Technology Organization, Neuilly-sur-Seine,

France
Report Number: Report No.RTO-MP-4
Abstract: Research on biases in thinking and judgement are frequently related to the strategic use of limited information processing resources by human operators. Human operators have been shown to have a limited capacity short-term memory and to experience problems in retrieving information quickly from long-term memory. The *limited information processing capability of the human operator is supposed to encourage the use of heuristics and biases which reduce memory requirements of processing*. Application of this model to decision making by operators in complex systems suggests that external cognitive support and effective information presentation are appropriate responses to increase the probability of correct decisions. In this paper it is argued that the *reluctance to shift out of skill-based processing encourages the maintenance of biases in thinking*. It is suggested that *awareness of their own biases and of the periods in which they are likely to occur may render decision makers more effective*. In addition, it suggests a new style of pilot's assistant technology which actively encourages the exchange of information between on-board systems and the operator. This participative dialogue management will help to ensure that inconsistencies between information and action are addressed before an ineffective mental model is activated and applied to key decisions.
Notes: L

Author: Cowan, T.H.
Year: 1996
Title: A Single Flexible, Rigorous Decision Making Process
Journal: School of Advanced Military Studies, Command and General Staff College, Ft Leavenworth, KS.
Pages: 53
Abstract: This monograph answers the question "Is there really more than one decision making process"? The history of the decision making process began with the Prussian Army. After they were defeated by Napoleon, they decided that they needed to educate their officers in how to make sound military decisions. This led to the great success that they experienced in the mid-1800's. The United States Army adopted their process in the 20th Century. As war became more complex, more steps were added to the process and the process became more and more complicated. In 1993 the Army added two new processes. The Army did this because the officers in the field complained that the Deliberate Decision Making Process (DDMP) was too rigid and too time consuming to use.

Upon careful examination of the three decision making processes using the problem solving methodology, *this report determines that there really is only one process. The others are simply permutations of the first*. Even though the DDMP is a very rigorous decision making process, it is important that commanders understand the spectrum of decision making that is inherent in the DDMP. With this knowledge they will know how to shorten the process.

As the United States Army prepares for combat in the 21st century, it is vital that commanders and staff fully understand the inherent flexibility in the DDMP. If they do not, then units of the future will find themselves dogmatically trapped in a process that was intended to be flexible from the beginning of its history.
Notes: L

Author: Crichton, M.
Year: 2001
Title: Training for decision making during emergencies
Journal: Psiholoska Obzorja/Horizons of Psychology
Volume: 10
Issue: 4
Pages: 7-22
Abstract: Discusses the use of *tactical decision games (TDGs) training methods* by emergency response personnel. TDGs are designed to enhance the non-technical skills of emergency personnel required for effective emergency management. Among the important non-technical skills are *decision making, communication, situation awareness, teamwork, and stress management skills*. TDGs encourage *learning through experience and directed practice*. Role playing participants are presented with dilemmas based on a limited amount of information: resultant decisions are later critiqued. Findings suggest that emergency response personnel will be better prepared, more equipped, and more able to deal with the demands endemic in any incident response as a result of repeated exposure to TDGs.
Notes: L

Author: Davies, S.P.
Year: 2003
Title: Initial and concurrent planning in solutions to well-structured problems
Journal: Quarterly Journal of Experimental Psychology: Human Experimental Psychology
Volume: 56A
Issue: 7
Pages: 1147-1164
Date: Oct
Abstract: Two experiments are reported, which consider planning behaviour in the context of a well-structured problem. *One question in the problem-solving literature is to what extent planning a solution to a problem takes place before attempting that problem and whether this takes precedence over planning while solving a problem, hereafter referred to as "concurrent planning"*. An additional question is whether the adoption of one mode of planning confers a performance advantage and under what circumstances one strategy is adopted in preference to others. The studies reported here set out to investigate the effects on performance of adopting different modes of planning and whether there is any relationship between the adoption of different strategic approaches and problem-solving performance. The results of these studies suggest that initial planning can enhance problem-solving performance, but only when problems remain relatively simple. As problem complexity increases the effects of initial planning appear to have little or no effect upon performance. In conclusion it is suggested that strategy use depends upon the interactions between individual preference for a given strategy, problem complexity, and the stage that one has reached in the development of a solution to a problem.
Notes: L

Author: Ferguson, S.
Year: 1998
Title: Twenty-first Century Leadership: Perils and Solutions
Journal: Naval War Coll., Newport, RI

Pages: 22
Abstract: Twenty-first century military leaders will operate on a battlefield that is fast-paced, fluid, and highly lethal. Technological systems will provide commanders with unlimited information and military capabilities on that battlefield. The development of our future military leaders will require special knowledge, skills, and abilities to sufficiently prepare them to operate in that environment. This paper will contend that immediate changes are needed to our education processes to create leaders at all levels that are more jointly educated and oriented. Changes in joint education and joint exposure are recommended. Concurrently, changes are needed in the way that future military leaders will make and implement decisions. *Proposals are offered to improve decision making skills* and decentralized execution. The combination of current military skills development, enhanced joint training, and decentralized, intuitive decision making offers the proper balance for development of future leaders. This combination is necessary to sufficiently prepare the human element of leadership to be compatible with the technological capabilities that will be available on the twenty-first century battlefield.
Notes: L

Author: Flin, R., Slaven, G., Stewart, K.
Year: 1996
Title: Emergency Decision Making in the Offshore Oil and Gas Industry
Journal: Human Factors
Volume: 38
Issue: 2
Pages: 262-277
Abstract: In July 1988, Occidental Petroleum (Caledonia) Ltd.'s North Sea oil platform, Piper Alpha, exploded with the loss of 167 lives. Although rare, such industrial disasters demonstrate that the task facing managers at high-hazard sites in an emergency is complex and characterized by time pressure, uncertainty, and danger. In this paper the authors examine the decision making required in a crisis by the offshore installation manager (OIM) and his or her emergency response team on an offshore oil installation. The paper summarizes the findings of a study in which the authors examined the selection and training of OIMs for crisis management and interviewed OIMs who had dealt with a real offshore emergency. The *characteristics of the decision making that the on-scene commander requires in an offshore crisis are discussed in terms of recent developments in theories of naturalistic decision making, with particular reference to recognition-primed decision making.*
Notes: L

Author: Gott, S.
Year: 1998
Title: Rediscovering Learning: Acquiring Expertise in Real World Problem Solving Tasks
Institution: Armstrong Laboratory
Pages: 40
Report Number: AL/HR-TP-1997-0009
Abstract: The importance of continuous learning in high-tech work settings is being rediscovered as industry and the military services react to external forces such as increasingly complex and rapidly changing equipment systems as well as highly competitive product service markets. Competitiveness in turn dictates a leaner, downsized workforce for the private sector, and diminished defence spending has resulted in

dramatic losses of personnel in the Armed Forces. Those who remain are expected to do more, and yet, performance demands routinely override training opportunities. Moreover on the job training that follows either the traditional master apprentice behavioural model or relies heavily on didactic instruction is typically impractical or ineffective. *An alternative learning oriented approach that accelerates skill acquisition in high-tech jobs is described here*. With this approach cognitive performance models provide both the input to instruction and the desired criterion performance to be attained. The instructional medium is an intelligent tutoring system. A knowledge elicitation approach called the PARI cognitive task analysis methodology is described, along with the cognitive models of performance yielded by this analysis. The performance models in turn inform a coached apprenticeship practice environment embodied in an intelligent computer tutor. The system was recently evaluated in a controlled experiment at three geographically separated Air Force workcentres. Results reveal that the experimental group significantly accelerated their acquisition of problem solving skills when compared to a matched control group; moreover, their newly acquired troubleshooting skills generalized to a novel equipment system.
Notes: L

Author: Graebener, R.
Year: 2000
Title: The Evolving Role of Analysis in Complex Military Decision-Making
Institution: Institute for Defense Analyses
Pages: 93
Report Number: IDA-D-2415
Abstract: The Synthetic Theatre of War (STOW) Advanced Concept Technology Demonstration (ACTD) concluded its life cycle with USJFCOM (operational user) acceptance of the federated simulation in FY 99. During the ACTD life cycle, USJFCOM required the technologies to support the following: Joint task force training (Unified Endeavor 98-1); Analysis of ACTDs (Joint Counter Mine); and joint experimentation (J9901, Critical Mobile Target, Attack Operations) circa 2015. This report documents the complexities associated with current and future problem-solving techniques necessary to meet the decision-maker's needs in the 21st century. The STOW ACTD is a case study in what to expect from future challenges facing the warfighter and the analytical community pledged to support the joint commander. Using the traditional problem-solving approach as a starting point, this paper addresses the question: "How can the decision-maker of tomorrow employ the latest technologies and analytical processes to make the best decision?" The answer lies in the following: Establish standard procedures for decisions; ensure all stakeholders are included; identify long-lead items early; and establish early working relationships between the maintainers of the analysis tools and the users.
Notes: L

Author: Haertel, C.E.J., Haertel, G.F
Year: 1997
Title: SHAPE-assisted intuitive decision making and problem solving: Information-processing-based training for conditions of cognitive busy-ness
Journal: Group Dynamics
Volume: 1
Issue: 3
Pages: 187-199

Abstract: The present study tested the usefulness of a normative model of decision making designed for individuals and teams that emphasized 5 processes needed in cognitively busy decision situations: *scrutinize symptoms, hypothesize solutions, analyze proposed solutions, perform modifications and corrections, and evaluate results (SHAPE).* All teams (102) were trained in task skills and practiced solving problems before the experimental decision-making situation, a cognitively busy computer-simulated decision situation. Half of the teams were trained in the SHAPE algorithm. Half of the teams received no decision-making training (the intuition condition). Results indicate that *SHAPE-assisted intuitive decision making is faster and more accurate than unassisted intuitive decision making. Furthermore, SHAPE-trained teams experienced lower levels of stress, maintained better task performance, and performed more synchronously than teams receiving no decision-making training.* Preliminary evidence that SHAPE creates a shared metacognitive strategy is presented.
Notes: L

Author: Hayes-Roth, B., Hayes-Roth, F.
Year: 1978
Title: Cognitive Processes in Planning
Pages: 93
Date: Aug
Report Number: RAND/WN-10268-ONR, TR-1
Abstract: We propose a model of the planning process. Planning is the predetermination of a course of action aimed at achieving a goal. The model assumes that planning comprises the activities of a variety of cognitive 'specialists.' Each specialist can suggest certain kinds of decisions for incorporation into the plan in progress. These include decisions about: (a) how to approach the planning problem; (b) what knowledge bears on the problem; (c) what kinds of actions to try to plan; (d) what specific actions to plan; and (e) how to allocate cognitive resources during planning. Within each of these categories, different specialists suggest decisions at different levels of abstraction. The activities of the various specialists are not coordinated in any systematic way. Instead, the specialists operate opportunistically, suggesting decisions whenever promising opportunities arise. We present a detailed account of the model and illustrate its assumptions with a 'thinking aloud' protocol. We also contrast the model with earlier models of planning and discuss implications for future research.
Notes: L

Author: Hayes-Roth, B., Thorndyke, P. W.
Year: 1980
Title: Decision making During the Planning Process
Pages: 61
Date: Oct
Report Number: RAND/N-1213-ONR
Abstract: Planning requires an individual to make a series of decisions about an intended course of action. This Note evaluates two major assumptions of an 'opportunistic' model of the planning process: (a) that planners make decisions at different levels of abstraction; and (b) that prior decisions influence subsequent decisions opportunistically, regardless of their respective levels of abstraction. The results of three experiments support these assumptions. In Experiment I, subjects sorted statements of different planning decisions according to similarity. A hierarchical clustering analysis of their sortings confirmed the

postulated levels of abstraction. In Experiments 2 and 3, subjects chose between alternative decisions, given a particular prior decision. In Experiment 2, the prior decision influenced subjects' choices between two alternative decisions at both higher and lower levels of abstraction than the prior decision. In Experiment 3, it influenced their choices between alternatives at two different levels of abstraction. This Note should interest researchers concerned with cognitive processes underlying planning.
Notes: L

Author: Innocenti, C.W.
Year: 2001
Title: Abbreviated Military Decision Making for Brigade Combat Teams
Journal: School of Advanced Military Studies, Command and General Staff College, Ft Leavenworth, KS.
Pages: 138
Abstract: This study investigates the Army's current military decision-making process and its
applicability to brigade level combat operations in a time-constrained environment. Tactical military decision making is an arduous process that many times occurs in less than ideal conditions. As the complexity of warfare increases and changes in the threat occur, the demand to develop tactical plans that leverage all the combat multipliers available to the commander, while providing the flexibility to maintain the initiative throughout the operation, becomes even more difficult. This problem is compounded further when decision making must occur in a time-constrained environment. This study examines the Army's doctrinal decision-making process and determines whether brigade combat teams can adequately utilize it in time-constrained combat situation to explore options, develop courses of action and produce a feasible plan. It specifically examines the techniques prescribed in doctrine to modify the process in a time-constrained environment, and identifies any issues related to those techniques.
This study concludes that the *three primary techniques described in doctrine for abbreviating the military decision-making process work, however, described techniques within the process for considering the enemy are inconsistent and inadequate*. An appendix is included in this study with a proposed technique to overcome the issues with regard to consideration of the enemy that were identified when using the current doctrinal decision-making process in a time-constrained situation.
Notes: L

Author: Isenberg, D.J.
Year: 1986
Title: Thinking and managing: a verbal protocol analysis of managerial problem solving
Journal: Academy of Management Journal
Volume: 29
Issue: 4
Pages: 775-788
Abstract: Examined whether there is anything distinctive about the way managers think and what cognitive processes account for more and less effective managerial problem solving and action planning. While thinking aloud, 12 general managers from 6 corporations solved a short business case. Three undergraduates performed the identical task. Content analyses of the verbal protocols suggested that the managers began planning courses of action relatively sooner, used more reasoning processes, and made fewer requests for

specific information than did the students. Correlations with independent ratings of the *effectiveness of action plans suggested that those managers who employed analogical reasoning and whose recommendations were specific generated better action plans than other managers. Findings are discussed in terms of a model of opportunistic thinking.*
Notes: L

Author: Kaempf, G.L., Wolf, S., Miller, T.E.
Year of Conference: 1993
Title: Decision Making in the AEGIS Combat Information Centre
Conference Name: Designing for Diversity. Proceedings of the Human Factors and Ergonomics Society 37th Annual Meeting
Conference Location: Seattle, Washington
Pages: 1107-1111
Date: October 11-15
Abstract: This paper presents the methods and findings of a study designed to identify the decision requirements for anti-air warfare officers in the Combat Information Centre of an AEGIS cruiser. Decision requirements include the decisions that systems operators make, the cognitive strategies they invoke to make these decisions, and the cues and factors essential for making these decisions. These requirements can be used to design training, human-computer interfaces, or decision supports. The researchers adopted a method based on Naturalistic Decision Making (NDM) research. NDM describes how people make decisions in real-world settings under conditions of time pressure, high risk, and ambiguity. This paper describes a process for obtaining data necessary for describing these decision processes. The central method is a semi-structured interview method, the Critical Decision Method (CDM). CDM was used to interview 31 experienced AEGIS personnel resulting in 14 incidents that reflect real problems experienced by the operational fleet. Analysis of these incidents revealed 183 decisions. Of these, 103 concerned situation assessments (SA). The operators used feature matching and story building to make all SA decisions. The operators invoked recognitional strategies to generate 95% of the course of action (COA) options and compared multiple options in only 5% of the COA decisions. The findings reported here indicate that *under conditions of time pressure and ambiguity: decision makers rarely use analytical decision strategies, they usually satisfice rather than optimize, they rely heavily on diagnostic decisions, and they invoke singular rather than comparative evaluations of courses of action.*
Notes: L

Author: Klein, G.A.
Year: 1997
Title: Making Decisions in Natural Environments. - Final rept. Aug 94-Dec 96
Pages: 35
Date: Feb
Report Number: ARI-SR-31
Abstract: This report surveys the field of naturalistic decision making *(NDM) and shows its potential for supporting the needs of the U.S. Army*. The report is written from the perspective of a researcher who has been active in developing models and methods in this new approach. The objective is to show the value of NDM for helping the Army address current challenges, including its use of information technologies, its need to downsize forces, and a change in its expected missions.
Notes: L/M

Author: Klein, G.A., Calderwood, R., Clinton-Cirocco, A.
Year of Conference: 1986
Title: Rapid Decision Making on the Fire Ground
Conference Name: A Cradle for Human Factors. Proceedings of the Human Factors Society 30th Annual Meeting
Conference Location: Dayton, Ohio
Pages: 576-580
Date: September 29-October 3
Abstract: The objective of this study was to examine the way decisions are made by highly proficient personnel, under conditions of extreme time pressure, and where the consequences of the decisions could affect lives and property. Fire Ground Commanders (FGCs), who are responsible for allocating personnel and resources at the scene of a fire, were studied using a critical incident protocol analysis. The major finding was that *in less than 12% of the decision points was there any evidence of simultaneous comparisons and relative evaluation of two or more options*. Instead the FGCs most commonly *relied on their experience to directly identify the situation as typical and to identify a course of action* as appropriate for that prototype. A *Recognition Primed Decision (RPD) model is proposed which emphasizes the use of recognition rather than calculation or analysis for rapid decision making*.
Notes: L

Author: Loffert, J.
Year: 2002
Title: Mission Analysis: Giving Commanders What They Need
Journal: Army Command and General Staff College, Fort Leavenworth, KS, School of Advanced Military Studies
Pages: 61
Abstract: The purpose of this monograph is to answer the research question: does the current process for executing mission analysis give commanders the information they need to develop timely, relevant, and constructive commander's intent and commander's guidance. This paper focused on the first two aspects of battle command: visualization and description. There are problems with the doctrinal mission analysis process that hinders commanders and their staffs in visualizing and describing an operation. The over-arching problem occurring during execution of the current mission analysis process is that staffs are not giving commanders what they need to complete their required deliverables at the conclusion of the mission analysis brief: timely, relevant, and constructive initial commander's intent and commander's planning guidance. In its current form, the mission analysis process fails to address three fundamental problems during the execution of mission analysis. First, it does not take into account the lack of sufficient relevant experience of most staff members to intuitively see the relevant conclusions from the information gathered by the process. Second, it does not adequately describe the complex nature of the commander and staff relationship and how the staff uses each step of the mission analysis process to assist the commander. Lastly, the mission analysis process does not assist staffs to present the information gathered from the process in a manner that properly frames the problem and relates proper context to the commander in order to facilitate the development of his intent and guidance. Although solving the problem of inexperience is beyond the scope of this paper, the proposal does recommend several methods commanders and staffs can use to mitigate for lack of relevant

experience. As for the other two problems, the mission analysis construct is good, but not complete.
Notes: L

Author: Lussier, J.W., Saxon, T.F.
Year: 1994
Title: Critical Factors in the Art of Battle Command
Journal: US Army Research Institute for the Behavioural and Social Sciences, Ft Leavenworth, KS.
Pages: 53
Date: Nov
Abstract: This study report focuses on the re-emergence of the importance of the art of battle command and the factors critical to it. First, the conceptualisation of battle command is discussed. Included in this discussion is how the concept of battle command differs from the concept of command and control, the consideration of battle command as an art and science, and the place of technology, information, and digitisation in the concept of battle command. Drawing on National Training Centre studies, traits of leaders, and the differences between experts and novices, the various competencies commonly associated with battle command are analysed. In keeping with the current BCBL conceptualisation of battle command, two fundamental aspects of battle command, leadership and decision making, are discussed. Research from both the military and non-military sector is presented on leadership and decision making and its relevance to battle command. Specifically, regarding leadership, the topics of leadership skills, leadership styles, communication and training are discussed. With *respect to decision making, the roles of intuitive and analytical judgements, planning and problem solving, critical thinking, and visualisation are considered.*
Notes: L

Editor: MacCarthy, B., Wilson, J.
Year: 2001
Title: Human Performance in Planning and Scheduling
City: London
Publisher: Taylor and Francis
Number of Pages: 466
Abstract: The study of planning and scheduling has the ultimate goal of improving industrial practice. Understanding how to make the best use of human skills and knowledge is essential in the design of technology and jobs, particularly where these involve decision making under uncertainty. This issue has been addressed in continuous process control, and in the nuclear and other high risk industries. More recent developments have been made in naturalistic decision making, distributed cognition and situational awareness, particularly with respect to aviation, transport and strategic planning. These same issues can be applied more broadly to production planning and scheduling in manufacturing as a whole. *Decisions are still made largely 'on the run', despite the introduction of intelligent systems and increased sophistication.*
Notes: L

Author: Milano, J.M.
Year: 1991
Title: Tactical Wargaming After H-hour: An Unstructured Mental Process. - Monograph rept
Journal: Army Command and General Staff Coll., Fort Leavenworth, KS. School of Advanced Military Studies
Pages: 58
Date: Dec
Abstract: This monograph investigates the suitability of the *Wass de Czege Combat Power Model as a framework for thought in which the military decision-making process*--specifically the critical steps of wargaming--*can occur at the tactical level of war*. The model can assist the decision-maker in understanding how to apply combat power, and it can further function as an analytical tool, especially in time-constrained situations. The monograph first discusses the historical development of the estimate process, leading to what is currently used in the US Army today. Included in this is a discussion of when the concept of wargaming first appeared in doctrine and how the wargaming methodology evolved-to its present format. *A description of the military decision-making process in use today follows, with emphasis on its inadequacies in time-critical situations at the lower tactical levels of warfighting*. Next is a description of the *recognition-primed decision-making theory developed by Gary A. Klein and associates and how this theory accurately delineates the process by which decision-makers, especially military leaders, make and assess decisions*.
Notes: L

Author: Nickerson, R.S., Feehrer, C.E.
Year: 1975
Title: A Review of Theoretical and Empirical Studies of Decision Making and Their Implications for the Training of Decision Makers
Pages: 226
Date: August
Report Number: NAVTRAEQUIPCEN 73-C-0128-1
Abstract: This report reviews theoretical and empirical studies of decision making. The purpose of the review was to identify results that would be applicable to the problem of training decision makers.
The literature on decision making is extensive. However, relatively few studies have dealt explicitly with the problem of training in decision making skills. The task, therefore, was to gather from the general literature on decision making any implications that could be found for training.
Decision making is conceptualised here as a type of problem solving, and the review is organised in terms of the following component tasks: *information gathering, data evaluation, problem structuring, hypothesis generation, hypothesis evaluation, preference specification, action selection, and decision evaluation*. Implications of research findings for training are discussed in the context of descriptions of each of these tasks.
A general conclusion drawn from the study is that decision making is probably not sufficiently well understood to permit the design of an effective general-purpose training system for decision makers. Systems and programs could be developed, however, to facilitate training with respect to specific decision-making skills. The development of more generally applicable training techniques or system should proceed in an evolutionary

fashion.
Training is one way to improve decision making performance; another is to provide the decision maker with aids for various aspects of his task. Because training and the provision of decision aids are viewed as complementary approaches to the same problem, the report ends with a *discussion of several decision aiding techniques that are in one or another stage of study or development.*
Notes: L

Author: Orasanu, J.
Year of Conference: 1995
Title: Training for Aviation Decision Making: The Naturalistic Decision Making Perspective
Conference Name: Designing for the Global Village. Proceedings of the Human Factors and Ergonomics Society 39th Annual Meeting
Conference Location: San Diego
Pages: 1258-1262
Date: October 9-13
Abstract: This paper describes the *implications of a naturalistic decision making (NDM) perspective for training aircrews to make flight-related decisions.* The implications are based on two types of analysis: (1) identification of distinctive features that serve as a basis for classifying a diverse set of decision events actually encountered by flight crews, and (2) performance strategies that distinguish more from less effective crews flying full-mission simulators, as well as performance analyses from NTSB accident investigations. *Six training recommendations are offered.*
Notes: L

Author: Schaafstal, A.M., Johnston, J.H., Oser, R.L.
Year: 2001
Title: Training Teams for Emergency Management
Journal: Computers in Human Behavior
Volume: 17
Issue: 5-6
Pages: 615-626
Abstract: Emergency management (EM), the decision making involved in directing the relief operation after a disaster or otherwise catastrophic accident, is an issue of great public and private concern because of the high stakes involved. Due to the nature of emergencies, and especially mass emergencies, EM teams are faced with decision making in stressful situations, information ambiguity and overload, and a significant level of uncertainty, whereby non-routine problem solving of a knowledge-based nature is required. An important characteristic of EM is that it is a team of teams; multiple teams that come from different organizations, with different organizational goals and different organizational cultures, that work together to minimize the negative effects of the emergency. As a consequence, EM requires good coordination and communication not just within, but also among the various teams involved. Coordination among teams should, therefore, be a key focus for training. This paper *describes EM within the context of naturalistic decision making, and proposes a framework, an event-based approach to training, together with a number of team training strategies that may be applicable to EM.* A brief assessment of available training technologies and recommendations for future research are discussed.
Notes: L

Author: Shoffner, W.A.
Year: 2000
Title: Military Decision-Making Process Time for a Change. - Monograph rept
Journal: Army Command and General Staff Coll., Fort Leavenworth, KS. School of Advanced Military Studies
Pages: 55
Accession Number: USACGSC/SAMS-AY-99-00
Abstract: The US Army's Military Decision-Making Process (MDMP) has been oft criticized as a time consuming and cumbersome process. Units typically devote so much time to developing and perfecting the plan that once the process is complete, there remains little time in which to implement it. If the time required by the MDMP were the only problem, then the solution might simply be to abbreviate or streamline the process commensurate with the time available. However, this is not the case. Even if planners are given a week, the MDMP still does not result in a 'perfect' plan. In fact, recent experience at the National Training Centre (NTC) indicates that despite extensive work by the staff many plans are discarded as soon as an engagement begins. This experience is consistent with Moltke's adage 'no plan survives the first shot'. This author does not suggest that planning is pointless, in fact, planning is essential because it develops a thorough understanding of the problem throughout an organization. However a tactical plan is useful only if it can adapt to the dynamic nature of the battlefield. A significant shortcoming of the MDMP is that it is rigid, inflexible, and does not adapt well to 'rapidly changing battlefield conditions'. This monograph *asserts that this method is fundamentally inappropriate for tactical planning because it results in only one solution (the selected friendly COA) optimized against only one possible set of circumstances (enemy COA)*. If circumstances change, the plan becomes useless because it is not adaptable to changing conditions.
Notes: L

Author: Sjoberg, L.
Year: 2003
Title: Intuitive vs. analytical decision making: Which is preferred?
Journal: Scandinavian Journal of Management
Volume: 19
Issue: 1
Pages: 17-29
Date: Mar
Abstract: This paper presents the results of a study of *preferences for intuitive as against analytical decision making* and of judgments in a wide variety of situations. The findings are *related to perceived control*, and to the *risks and chances of negative and positive outcomes* of the decisions, respectively. Control was found to be positively related to preference for an intuitive mode of making decisions. It was also found that preference for an intuitive mode of decision making was most pronounced among private consumer decisions, the outcomes of which were also seen by the decision makers as being most accessible to their own influence. In particular, judgments made by professionals not directly affected by the outcome of the decision were regarded as requiring a more analytical approach. These findings are discussed in relation to the *frequent claims of the experts to possess a high level of intuitive skill*.
Notes: L

Author: Smith, K.R.
Year: 1998
Title: Incorporating Feedback into the Military Decision Making Process to Improve Decision Making Performance
Journal: School of Advanced Military Studies, Command and General Staff College, Ft Leavenworth, KS.
Pages: 50
Date: December
Abstract: Tactical problems that confront commanders are filled with *uncertainty and ambiguity*. The complexities of the tactical environment combined with man's cognitive limitations can cause intendedly (sic) rational individuals to make decisions which are not totally rational. Many initiatives look to technology to simplify the complexities of this decision making environment. This monograph examines recent theories from decision making and judgement research to identify means to improve the human aspects of decision making in staffs.
A recent theory for managing and improving decision accuracy in staffs is presented along with a feedback intervention theory. Negative trends, reported by the centre for Army Lessons Learned are analysed with respect to these theories to illustrate which core constructs negatively influence decision making accuracy. A feedback intervention, in the form of a modified after action review - modified because it is more prescriptive and less focussed on discovery learning - is recommended as a formal change to the military decision making process to overcome these negative trends and improve decision making accuracy.
Notes: L

Author: Vinze, A.S., Sen, A., Liou, S.F.
Year: 1993
Title: Operationalising the opportunistic behaviour in model formulation
Journal: International Journal of Man-Machine Studies
Volume: 38
Issue: 3
Pages: 509-540
Date: Mar
Abstract: Used the think-aloud approach to study the process of model formulation as undertaken by 9 Ss, 3 expert modellers each in the domains of production planning, forecasting, and auditing. An evaluation of the verbalizations by the Ss revealed the *predominant use of opportunism in the process. Opportunism is one approach to problem solving in which the modeller follows the most promising leads at any point in time*. A cognitive model was used to categorize and understand the expert protocols as derived from the verbalizations. A comparison of the verbalizations using this model shows similarity in the process of formulation. The cognitive model was operationalised using a blackboard architecture.
Notes: L

Author: Watt, C.
Year: 2000
Title: An Analysis of Decision Making Strategies Used By P-3 Pilots in Hazardous Situations
Journal: naval postgraduate school, Monterey, CA

Abstract: Effective decision making in aeronautical environments, which often involves high elements of risk, is critical to mission success. Unfortunately, no proven methodology exists to train pilots to make successful decisions. Cockpit decision making has relied on *traditional analytical models and methodologies that underestimate the role of pilot experience, expertise and judgement*. Naturalistic Decision Making models (NDM) contend that decision makers facing real-world decisions use experience and judgement to make timely decisions without analyzing a multitude of alternatives. This thesis analyzes 438 P-3 aviation hazard reports (hazreps) to ascertain which cognitive strategies from either the analytical or naturalistic methodology are more appropriate for handling malfunctions situations. The author *presents a hybrid model of decision making by P-3 pilots based on the results of the analysis and strategies from both methodologies*. This thesis recommends that decision making training be treated as a core activity of pilots not only in flight school, but alter qualification is complete. Training pilots to become experts will improve situational awareness and reduce the number of unfavourable outcomes in hazardous situations.
Notes: L

4.4. Journal Special Editions, Conference Proceedings and Books

Journal: Journal of Behavioural Decision Making
Volume: 14
Issue: 5
Year: 2001

Author: Yates, J.F.
Title: Forum On Naturalistic Decision Making - Editorial
Pages: 329-389
Author: Lipshitz, R., Klein, G.A., Orasanu, J., Salas, E.
Title: Taking stock of naturalistic decision making
Pages: 331-352
Author: Klayman, J.
Title: Ambivalence in (not about) naturalistic decision making
Pages: 372-373
Author: Gonzalez, R.
Title: Decision making in real life
Pages: 365-367
Author: Roelofsma, P.H.M.P.
Title: Evaluating ten years of naturalistic decision making: welcome back in the lab!
Pages: 377-379
Author: Elstein, A.S.
Title: Naturalistic decision making and clinical judgement
Pages: 363-365
Author: Clemen, R.T.
Title: Naturalistic decision making and decision analysis
Pages: 359-361
Author: Bordley, R.F.
Title: Naturalistic decision making and prescriptive decision theory
Pages: 355-357

Author: Mann, L.
Title: Naturalistic decision making: still finding its way
Pages: 373-377
Author: Jungermann, H.
Title: One mode of decision making (research) - no less, no more
Pages: 367-370
Author: Whyte, G.
Title: Perspectives on naturalistic decision making from organisational behaviour
Pages: 383-384
Author: LeBoeuf, R.A., Shafir, E.
Title: Problems and methods in naturalistic decision making research
Pages: 373-375
Author: Cooksey, R.W.
Title: Pursuing an integrated decision science: does 'naturalistic decision making' help or hinder?
Pages: 361-362
Author: Todd, P.M., Gigerenzer, G.
Title: Putting naturalistic decision making into the adaptive toolbox
Pages: 381-383
Author: Kerstholt, J., Ayton, P.
Title: Should NDM change our understanding of decision making?
Pages: 370-371
Author: Bazerman, M.H.
Title: The study of 'real' decision making
Pages: 353-355
Author: Teigen, K.H.
Title: Two fuzzy themes in a clear message
Pages: 379-380
Author: Lipshitz, R., Klein, G.A., Orasanu, J., Salas, E.
Title: A welcome dialogue - and the need to continue
Pages: 385-389
Author: Caverni, J-P.
Title: What is really naturalistic in naturalistic decision-making research?
Pages: 357-358

Conference Name: Fourth Conference on Naturalistic Decision Making
Conference Location: Warrenton, VA
Year of Conference: 1998
Author: de Keyser, V., Nyssen, A.
Title: The management of temporal constraints in naturalistic decision making: the case of anaesthesia

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Author: Cohen, M.S., Freeman, J.T., Thompson, B.
Year: 1998
Title: Critical thinking skills in tactical decision making: a model and a training strategy
Editor: Cannon-Bowers, J.A., Salas, E.
Book Title: Making Decisions Under Stress: Implications for Individual and Team Training
City: Washington, DC
Publisher: American Psychological Association

Pages: 155-189

Editor: Kahneman, D., Slovic, P., Tversky, A.
Year: 1982
Title: Judgement under uncertainty: Heuristics and biases
City: Cambridge, MA
Publisher: Cambridge University Press
Editor: Gilovich, T., Griffin, D., Kahneman, D.
Year: 2002
Title: Heuristics and biases: the psychology of intuitive judgement
City: Cambridge
Publisher: Cambridge University Press
Number of Pages: 857
Abstract: A collection of previously published papers on the subject of heuristics and biases. Contains papers on intuitive reasoning, intuitive judgement, systems of reasoning, and deviant functionalist metaphors using the examples of intuitive politicians, theologians and prosecutors.

Author: Pascual, R., Henderson, S.
Year: 1997
Title: Evidence of naturalistic decision making in C2
Editor: Zsambok, C.E., Klein, G.A.
Book Title: Naturalistic Decision Making
City: Mahwah, NJ
Publisher: Lawrence Erlbaum Associates
Pages: 217-226

Author: Pliske, R., Klein, G.
Year: 2003
Title: The naturalistic decision making perspective
Editor: Schneider, S.L., Shanteau, J.
Book Title: Emerging perspectives on judgement and decision research
City: Cambridge
Publisher: Cambridge University Press
Pages: 559 - 585
Abstract: Researchers affiliated with the Naturalistic Decision Making (NDM) perspective study how *people use their experience to make decisions* in field settings. In this chapter we present an overview of the NDM perspective by providing a brief history of its development, a description of the types of models and methods used by NDM researchers, and examples of the types of research currently included in this approach. We also summarize several studies conducted with weather forecasters that have used both the traditional and naturalistic perspectives in order to illustrate the relationship between the approaches. We conclude with a discussion of the strengths and weaknesses of the NDM perspective.

Author: Pliske, R.M., McCloskey, M., Klein, G.A.
Year: 2001
Title: Decision Skills Training: Facilitating Learning from Experience
Editor: Salas, E., Klein, G.A.
Book Title: Linking expertise and naturalistic decision making

City: West Newton, MA
Publisher: Argosy
Pages: 37-53

Editor: Schneider, S.L., Shanteau, J.
Year: 2003
Title: Emerging perspectives on judgement and decision research
City: Cambridge
Publisher: Cambridge University Press
Number of Pages: 713
Abstract: A collection of invited papers outlining where judgement and decision making are expected to go in the 21st century. The most relevant chapter (for this project) in this book is 'The Naturalistic Decision Making Perspective' by Pliske and Klein (p.559).

4.5. Other References

These references are likely to be relevant, although there was no associated abstract to consider.

Author: Cannon-Bowers, J.A., Salas, E., Pruitt, J.S.
Year: 1996
Title: Establishing the boundaries of a paradigm for decision making research
Journal: Human Factors
Volume: 38
Issue: 2
Pages: 193-205

Author: Cohen, M.S., Freeman, J.T., Wolf, S.
Year of Conference: 1996
Title: Meta-recognition in time-stressed decision making: recognising, critiquing and correcting
Conference Name: Proceedings of the 40th Human Factors and Ergonomics Society
Pages: 206-219

Author: Driskell, J.E., Salas, E., Hall, J.K.
Year of Conference: 1994
Title: The effect of vigilant and hypervigilant decision training on performance
Conference Name: Annual meeting of the Society of Industrial and Organisational Psychology
Conference Location: Nashville, TN

Author: Fallesen, J.J.
Year: 1995
Title: Overview of practical thinking instruction for battle command
Institution: US Army Research Institute for the Social and Behavioural Sciences, Ft Leavenworth, KS
Report Number: Research Report 1685

Author: Gettys, C.F., Fisher, S.
Year: 1979
Title: Hypothesis plausibility and hypothesis generation
Journal: Organisational Behaviour and Human Performance
Volume: 24
Pages: 93-110

Author: Hair, D.C., Pickslay, K.
Year: 1992
Title: Development of Computer Support for Naturalistic Decision Making
Pages: 24
Date: Dec
Report Number: TR-1558
Abstract: This project developed software support tools aimed at decision making in real time involving incomplete or uncertain data sets. A particular emphasis was placed on complementing naturalistic decision making approaches.

Author: Hammond, K.R., Hamm, R.M., Grassia, J., Pearson, T.
Year: 1987
Title: Direct comparison of the efficacy of intuitive and analytical cognition in expert judgement
Journal: IEEE Transactions on Systems, Man and Cybernetics
Volume: 17
Issue: 5
Pages: 753-770

Author: Kaempf, G.L., Klein, G.A., Thordsen, M.L., Wolf, S.
Year: 1996
Title: Decision Making in Complex Command and Control Environments
Journal: Human Factors
Volume: 38
Issue: 2
Pages: 220-231

Author: Klein, G.A., Wolf, S., Militello, L., Zsambok, C.E.
Year: 1995
Title: Characteristics of skilled option generation in chess
Journal: Organisational Behaviour and Human Decision Processes
Volume: 62
Issue: 1
Pages: 63-69

Author: Mosier, K.L.
Year of Conference: 1991
Title: Expert Decision Making Strategies
Conference Name: Proceedings of the Sixth International Symposium on Aviation Psychology
Conference Location: Columbus, OH
Pages: 266-271

5. Major Concepts Apparent from this Survey

Naturalistic decision making is a comparatively new field of study, originating in the late 1980s. It has been subject to some rigorous debate, although this has served to test and advance its theoretical tenets. Its place in the repertoire of decision making approaches is accepted by all practitioners, with remaining debate centring around when and where it is more appropriate to use NDM than other decision making techniques (e.g. analytical decision making).

The wide acceptance of NDM stems from the intuitive sense that it makes. Further, many studies have shown the prevalence of the approach in decision making. These findings have been facilitated by the universally understood and accepted definition first proposed by Klein et al (1986) and added to by others (Klein et al, 1990; McCarthy and Wilson, 2001; Anderson, 2000). NDM encompasses a number of decision making nomenclatures, including Recognition-Primed Decision making (RPD), analogical problem solving, opportunistic and intuitive decision making. These can be contrasted with 'traditional' approaches to decision making using analytic or rational approaches (see also Table 3 for a comparison of the major features of NDM and analytic decision making).

The main difference between NDM and analytic approaches to decision making is the degree to which all factors and all possible solutions are considered. As suggested by one of its constituent techniques (RPD), NDM is based on recognition of the features of a situation according to 'best fit' (satisficing). This recognition will be based on experience of the situation or its component features. Experience will also have provided a repertoire of possible solutions, from which one is chosen, again according to satisficing criteria.

Analytic Decision Making	Naturalistic Decision Making
Generation of many options for comparison purposes; Comparison of multiple options to themselves or a standard; Stable conditions and information within the decision event; Stable goals within the decision event; Time intensive; Staff/personnel intensive.	Situation assessment in addition to option selection; Single option construction and modification; Single option evaluation; Changing conditions and ambiguous information; Shifting goals; Time constraints in deciding what to do; Previous experience of the decision maker in the decision making event; Tendency to be quick; Often involves an individual.

Table 3: Comparison of analytic and naturalistic decision making

NDM is particularly useful for decision making tasks subject to a fast tempo and in the presence of incomplete or uncertain data sets. Lipshitz and Strauss (1997) discriminated between three types of uncertainty:

- Inadequate understanding;
- Incomplete information; and
- Undifferentiated alternatives.

They also identified five coping strategies:

- Reducing uncertainty;
- Assumption-based reasoning;
- Weighing pros and cons of competing alternatives;
- Suppressing uncertainty; and
- Forestalling.

Inadequate understanding was primarily addressed by reduction, incomplete information by assumption-based reasoning, and conflict among alternatives by weighing pros and cons. It has been claimed that NDM provides insights into battlefield success such as 'coup d'oeil' as well as operations-level (as opposed to tactical- or strategic-level) inefficiencies in planning.

Pounds and Fallesen (1994) also identified strategies, which they split into three classes and a number of subordinate categories. The classes of strategy identified were managing information, controlling progress and making choices. The subordinate categories included:

- Considering hypotheses;
- Combining information;
- Managing the amount of information;
- Ordering processes by hierarchical structures;
- Sequencing processes;
- Ordering processes by merit;
- Managing the number of options using compensatory choice; and
- Using noncompensatory choice.

Others have focused on training NDM approaches. For instance, Klein and Wolf (1995) offered four guidelines for training NDM:

- Build expertise rather than teaching generic analytical strategies;
- Support rather than replace the strategies people use;
- Make the decision requirements specific to the task content; and
- Model the cognitive processes of subject matter experts.

To do this, analysis must define the cues, patterns and strategies used by experts. If this is not possible, then it is possible to train people to learn like experts. Other generic heuristics have been proposed. For instance, Haertel and Haertel (1997) proposed 'SHAPE': scrutinize symptoms, hypothesize solutions, analyse proposed solutions, perform modifications and corrections, and evaluate results. Most training syllabi have a tendency toward greater use of simulations, games or other experiential training approaches.

There has also been research into situational triggers for NDM. As well as time-pressure and uncertainty, perceived control, risks, and the chances of positive or negative outcomes seem to determine the decision making approach adopted. Control was positively correlated with NDM, as was the degree to which the outcome would only affect the decision maker, while the less impact the decision would have on the decision maker, the more likely analytic techniques would be used (perhaps due to perceived risk of making a bad decision on someone else's behalf).

Most researchers make the implicit statement that NDM approaches are better than analytic approaches, but some do not claim this. Cowan (1996) maintains there is only one decision making process, and all others are simply permutations of the first. Cook, Elder and Ward (1998) suggest that a reluctance to shift out of skill-based processing (of which NDM is an example) encourages the maintenance of biases in thinking, and consequently sub-optimal decision outcomes. Marr (2001) states that analytic decision making is a necessary precursor to intuitive decision making. Dejarnette however claims that NDM and rational, analytic approaches are complementary, with NDM techniques aiding in synchronisation of battlefield effects and coup d'oeil through its use in non-linear decision making. This view echoes some of the points made by Marr (2001).

Most papers, however, support the applicability of NDM and other intuitive decision making approaches to military decision making, planning, course of action development and wargaming at operational and tactical levels. From this literature survey, it would seem that there is a corpus of previous work on which to base the application of intuitive decision making approaches to the OPP, including the development of new training approaches and decision support software.

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14. ABSTRACT

(U) The intention of Project Minerva is to re-examine Land Force Command and Control (C2) in light of the implementation of digitized C2 systems. This will be done within the context of the Athene Tactical System, which is to be delivered over the next year. The Land Force wants to develop new procedures that capitalize on the strengths of digitization. Project Minerva will focus on the Operations Planning Process (OPP), which is the prescribed method of planning for a mission.

The OPP, as described in doctrine, is an analytical approach to planning. That is, the doctrine requires the planner to consider exhaustively all the factors affecting a mission and develop a number of potential Courses of Action (COA). The fresh consideration of the OPP permits the consideration of alternative styles of decision making. In the past 15 – 20 years much attention has been paid to so-called Naturalistic Decision Making (NDM) styles. These styles are alternatively known as 'intuitive' or 'recognition-primed' and are considered more representative of the style adopted by most people much of the time.

It is hoped that Project Minerva will afford the opportunity to compare and contrast the analytical and intuitive decision making approaches within the context of operations planning. The outcome will provide valuable data that can be used in the development of digitized C2 systems. As a first step toward this opportunity, a literature survey was undertaken to identify literature that would likely be relevant to a discussion of decision making in planning and the training of decision making skills, as well as development of new planning and training concepts. A particular emphasis was placed on literature that focused on intuitive approaches.

This report provides an annotated bibliography of the decision making literature deemed to be of highest relevance to the aims of Project Minerva. This literature is categorised into high, medium and low relevance (low relevance is merely a comparative term; the papers are still relevant to the discussion). Further, the main issues apparent from the literature associated with decision making in planning are summarised.

(U) Le projet Minerva réexamine le commandement et le contrôle (C2) de la Force terrestre à la lumière de la mise en application de systèmes C2 numérisés, et ce, dans le cadre de la mise en œuvre du Système tactique Athene, qui aura lieu au cours de l'année prochaine. La Force terrestre veut élaborer de nouvelles procédures qui mettront à profit les forces de la numérisation. Le projet Minerva portera principalement sur le processus de planification opérationnel (PPO), la méthode de planification prescrite pour une mission.

Le PPO, tel que présenté dans la doctrine, est une approche analytique de la planification. C'est-à-dire que la doctrine oblige le planificateur à étudier en profondeur tous les facteurs pouvant influer sur une mission et à considérer un certain nombre d'options. Le nouveau type d'examen du PPO permet d'envisager d'autres styles de processus décisionnel. Au cours des 15 à 20 dernières années, on a porté une grande attention aux soi-disant styles de prise de décision naturalistes. Ces styles, sont parfois appelés « intuitifs » ou « basés sur la reconnaissance », et l'on estime qu'il représentent davantage le style adopté par la majorité des gens la plupart du temps.

Nous espérons que le projet Minerva nous permettra de mettre en contraste les processus décisionnels dits analytiques et intuitifs pour les comparer dans le cadre de la planification opérationnelle. Les résultats offriront des données utiles qui pourront servir lors de l'élaboration de systèmes C2 numérisés. À titre de premier pas vers cette réalisation, on a entrepris une recherche bibliographique pour identifier les documents pertinents à l'étude du processus décisionnel appliqué à la planification et au développement d'habiletés en matière de prise de décision, ainsi qu'à l'élaboration de nouveaux concepts de planification et d'entraînement. On a mis un accent particulier sur la documentation portant sur les approches intuitives.

Ce rapport comprend une bibliographie commentée des documents traitant du processus décisionnel, qui présentent le plus grand intérêt à l'égard des buts du projet Minerva. La documentation est classée selon trois degrés de pertinence : haute, moyenne et basse (la cote « basse » n'est qu'un terme de comparaison – les travaux demeurent pertinents aux fins de l'étude). De plus, les enjeux principaux qui ressortent de la documentation et qui sont liés au processus décisionnel appliqué à la panification ont fait l'objet d'un résumé.

15. KEYWORDS, DESCRIPTORS or IDENTIFIERS

(U) Land Force; Command and Control (C2); Athene Tactical System; digital; Operations Planning Process (OPP); decision making